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FRANK W. DE WOLF, *Chief*

EXTRACT FROM BULLETIN No. 43

GEOLOGY AND MINERAL RESOURCES OF THE MORRIS QUADRANGLE

BY

HAROLD E. CULVER

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GEOLOGY AND MINERAL RESOURCES OF THE MORRIS QUADRANGLE

By Harold E. Culver

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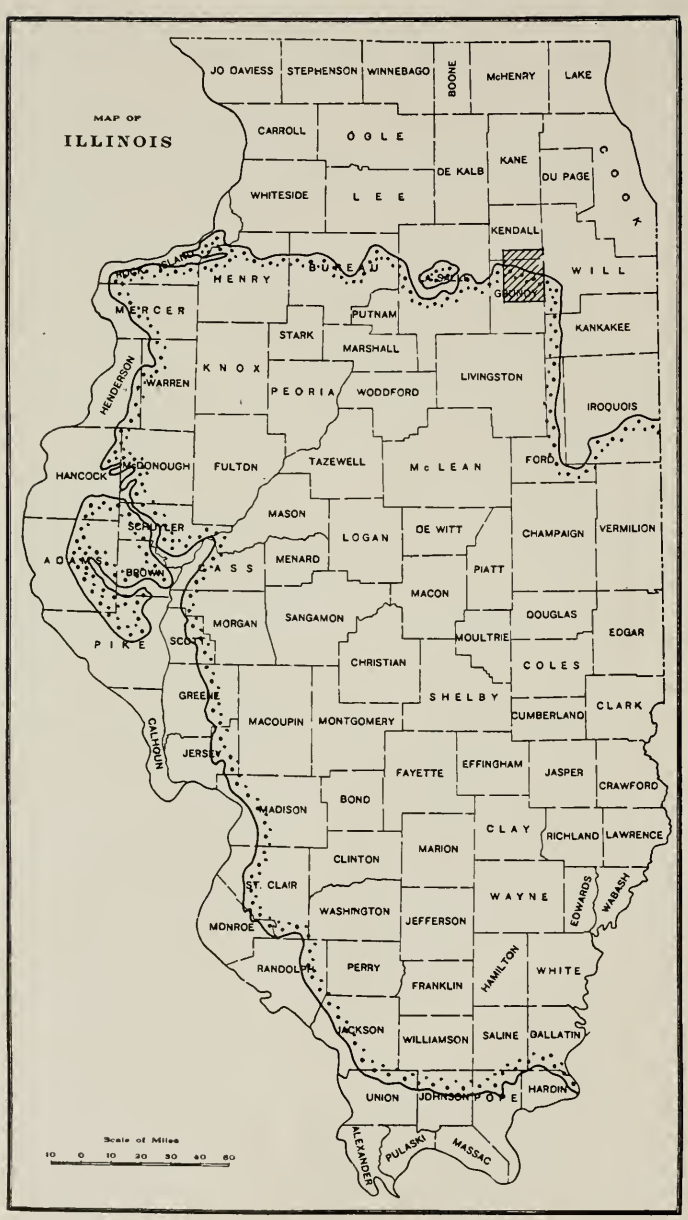

Fig. 12. Index map of Illinois, showing the location of the Morris Quadrangle. The stippled boundary outlines the Illinois coal field.

CHAPTER I—INTRODUCTION

Position

The region examined in this investigation lies along Illinois River in the vicinity of Morris (fig. 12). It comprises approximately half of Grundy County and a three-mile strip nearly across the southern part of Kendall County. The area has a width of 15 minutes of longitude, lying between meridians 88°15′ and 88°30′ west longitude, and a length of 15 minutes of latitude, lying between parallels 41°15′ and 41°30′ north latitude. The quadrangle includes 224.41 square miles within its boundaries, which disregard section, township, and county lines, being drawn in accordance with a plan for the systematic mapping of all the land in the United States.

General Relations

While at present primarily of importance for its agriculture, this region is one that will be benefited by the proposed Lakes-to-Gulf waterway, which, in addition to its stimulating effect upon farming, may make possible a greater development of its other industries. In earlier days before the utilization of the thick coal beds in the southern part of the State, coal mining was an important industry within the Morris quadrangle, although in 1920 there is but one shipping mine in operation.

Geologically the quadrangle is of interest because it includes a portion of the present boundary of the Eastern Interior Coal Basin, which comprises the coal lands of all of Illinois, Indiana, and western Kentucky. Within the "Coal Measures" here exposed are found the famous fossil beds of Mazon River, from which collections of almost perfectly preserved remains of plants and animals have been taken to many parts of the world. In addition, the Pleistocene or Glacial history of the region is of special interest since this portion of the valley of Illinois River was the site of an interesting series of drainage changes which were closely related to the development of glacial Lake Chicago and its outlet river.

Acknowledgments

In the gathering of data for this investigation the writer has enjoyed the courteous coöperation of a large number of people living within the quadrangle. He is especially indebted to the well drillers of the region for well logs, and to the mine operators for underground data.

Bulletin 10 of the Coöperative Mining Investigations[1] has been very helpful and has been freely drawn upon, as have some of the unpublished data gathered by former members of the Survey staff.

[1]Cady, G. H., Coal resources of District I: Ill. Coal Mining Investigations Bull. 10, 1915.

Credit is due Mr. Frank Collins Baker, who kindly determined the Pleistocene fossils, and offered suggestions as to the correlation of the enclosing deposits.

The writer wishes to express his appreciation of help given by the several members of the Survey staff, particularly Professor T. E. Savage, who determined the Paleozoic fossils, and Professor Morris M. Leighton with whom the Pleistocene study was initiated, and who has given the benefit of his experience in glacial investigations in this region, both by field assistance and by criticism of the Pleistocene chapters.

TOPOGRAPHY

The quadrangle includes the central part of the so-called Morris Basin. To the traveler the basin-like shape is not readily apparent because of its

Fig. 13. The head of the Illinois from the west side of Minooka Ridge. The Desplaines is seen in the middle distance, with the Kankakee coming in from the south

extreme shallowness, but is evident from the topographic map, and is emphasized by the arrangement of stream courses.

Relief

The relief of the region as a whole is slight, there being less than 200 feet of difference between the highest and lowest points in the quadrangle. The greatest local relief is found at Dresden Heights, where the Illinois has cut a sharp bank 120 feet high in the glacial deposits of Minooka Ridge (fig. 13). The other features of pronounced relief are a short ridge in section 13 of Saratoga Township, the cemetery ridge west of Morris, and the sharply incised valleys of some of the streams in the southwest part of the quad-

rangle. Elsewhere the topography is of monotonous smoothness, the greater part of the area lying between 540 and 620 feet above sea level.

Notwithstanding this notable lack of relief, certain topographic features of the region are not without interest. For example, Ridge Road, leading northeast from Morris, runs along the upper edge of a prominent embankment, a topographic form obviously unrelated to the flat adjoining on the north. Similarly, the irregular depression of Goose Lake, the flat knolls to the north, and the collection of dunes known as Sand Ridge to the south are features suggestive of interesting relations.

It is evident to the careful observer that the topography of pre-glacial time has been almost obliterated by the work of later agents. Furthermore, it becomes apparent upon inspection of the region that the general smoothness is largely due to the work of ice, while the relation of the local relief features to the valley of the Illinois strongly suggests their origin in later stream action.

Drainage

The master stream of the quadrangle is the Illinois, which heads within half a mile of the eastern boundary of the quadrangle at the junction of the Des Plaines and Kankakee rivers. The latter stream has a northerly course above that point and enters the quadrangle about two miles to the south near the point where it is crossed by the County Line Bridge.

The Illinois flows a little south of west at a velocity which varies from ½ to 3 miles an hour. From data gathered at the Federal gaging station at Elgin, Joliet, and Eastern Railway bridge about seven miles east of Morris,[2] the variation in measured volume amounts to 57,000 second feet, the extremes of observed flow being 7,000 and 64,000 second feet. With these changes, the water level fluctuates as much as 25 feet, the lowest recorded stage being 486 feet and the highest 511 feet above sea level. The flood plain shows great irregularity of outline but has an average width of about a mile. Numerous sloughs and lakes on the flood plain indicate relatively recent changes in the channel. Another feature worthy of notice is the abundance of elongate low-water islands of silt which characterize this portion of the Illinois as a depositing stream. By way of contrast, it is of interest to note that the Kankakee in its lower course is eroding its channel in resistant sandstone and limestone beds. In lesser degree this is characteristic of the Des Plaines also.

No tributaries of consequence enter the Des Plaines or the Kankakee within the quadrangle. The Illinois, however, has four prominent tributaries and several small ones. The two largest, Mazon River on the south and Aux Sable Creek on the north, drain more than three-quarters of the area. From the northwest comes Nettle Creek, a stream of two branches but no well

[2]Water Resources of Illinois: Rivers and Lakes Commission, p. 34, 1914.

developed tributary system. From the southwest flow Waupecan Creek and Bills Run, the latter of recent development without tributaries or branches, the former comparable in character with Nettle Creek on the north.

Inspection of the topographic map of the region suggests plainly a relation between the courses of the streams and the early history of Morris Basin. In the case of every stream draining the western half of the quadrangle the course shows a more or less distinct difference in trend in the upper and lower portions. This change in trend occurs at about the level of the earliest lake of which we have record in this depression.

The arrangement of stream courses has been referred to as emphasizing the shape of the Morris Basin. This type of drainage, characterized by the control of stream courses by the original slope of the land surface is known as *consequent*, and marks this as a region just starting on a cycle of erosion.

Culture

This district exhibits rural settlement rather than urban. Morris, county seat of Grundy, has a population of about 5,000; Coal City, including the old mining villages of Eileen, Carbon Hill, and Diamond, has approximately 3,000 inhabitants. Lisbon and Minooka have a few hundred each.

Nearly all the land is under cultivation, aside from the small undrained areas along the Illinois and the forested tracts. The woodlands are restricted to stream courses and sand areas, and, as shown by the topographic survey of 1915, comprise less than five per cent of the total area of the quadrangle. That portion of Grundy County included in the quadrangle has less than ten square miles of wooded land, while the Kendall County part has less than one square mile. The soil is for the most part fertile, and good crops are the rule. The production of certain areas has been increased by the addition of limestone and phosphate.

The region is well supplied with roadways, which follow the section lines in the main. Along the Illinois valley, however, the roads are parallel to its trend. There are many miles of hard surfaced roads, so that during most of the year a large part of the district is accessible by automobile. The mileage of paved road is being greatly increased at present with the completion of the Chicago-Illinois Valley highway and other main thoroughfares.

Adequate rail service is furnished by the lines between Chicago and the southwest. The main line of the Chicago, Rock Island and Pacific Railroad passes through Morris and Minooka, that of the Atchison, Topeka and Santa Fe Railway passes through Coal City, while a branch of the Cleveland, Cincinnati, Chicago and St. Louis Railroad crosses the extreme southwestern part through Wauponsee. The eastern part of the quadrangle is also served by the Elgin, Joliet and Eastern Railway. Additional service is provided by two electric lines, the Chicago, Ottawa and Peoria Railway, and the Illinois Valley and Fox River Union.

CHAPTER III—DESCRIPTIVE GEOLOGY

Solid rock of sedimentary origin underlies the loose surficial material in all parts of the quadrangle at depths ranging from a few inches to more than 120 feet. In the valleys of the larger streams, and rarely elsewhere, are scattered exposures of limestone, shale, or sandstone, which, as shown by drilling operations, are continuous under wide areas to a depth of more than 2,000 feet. Numerous borings of not more than a few hundred feet have been made in search of water, coal, oil, or gas. There are also a few deeper wells, of which that on the farm of Mr. Abe Hoge, Sr., located in NW. ¼ NW. ¼ sec. 25, T. 34 N., R. 6 E., reaching 1,921 feet, is perhaps the deepest.

From the logs of these holes, together with field studies of the outcrops in this and adjoining quadrangles, the geologic column showing the sequence and thickness of the strata for this region has been constructed. The rocks belong to a group of strata known as the Paleozoic, which is conveniently subdivided into seven systems, two of which are known to outcrop in the Morris quadrangle, one other being known from drilling.

The generalized geologic section (fig. 14) is typical of the quadrangle, but not exactly duplicated in any one boring. The reason for dissimilarity in different borings will become clear upon inspection of the areal map (Pl. III). A well near Lisbon will enter bed rock of Middle Ordovician age, one near Minooka will start in Upper Ordovician strata, while one near Coal City will pass first through Pennsylvanian beds, then through Upper, Middle, and Lower Ordovician beds, and since the thickness of these formations varies from place to place, none of these wells will encounter a section exactly like that given above.

Cambrian System

The Cambrian System, which includes the oldest rocks encountered in this region, lies more than 1,000 feet beneath the surface and has been reached by but few wells within the Morris quadrangle. Consequently it is little known and has no economic importance since it furnishes only water, which, though abundant, is of an inferior grade. At least two wells have been drilled into the Cambrian, the first in 1875, on section 25, Nettle Creek Township (T. 34 N., R. 6 E.), the Hoge well mentioned earlier, and the second in 1886 in the village of Minooka. No record of the latter is available, but that of the former makes possible certain conclusions regarding these deeply buried strata. The Hoge well encountered beds believed to be of Cambrian age at 1,200 feet and was continued for about 700 feet more. The complete log, with geologic interpretations, is given below. In both

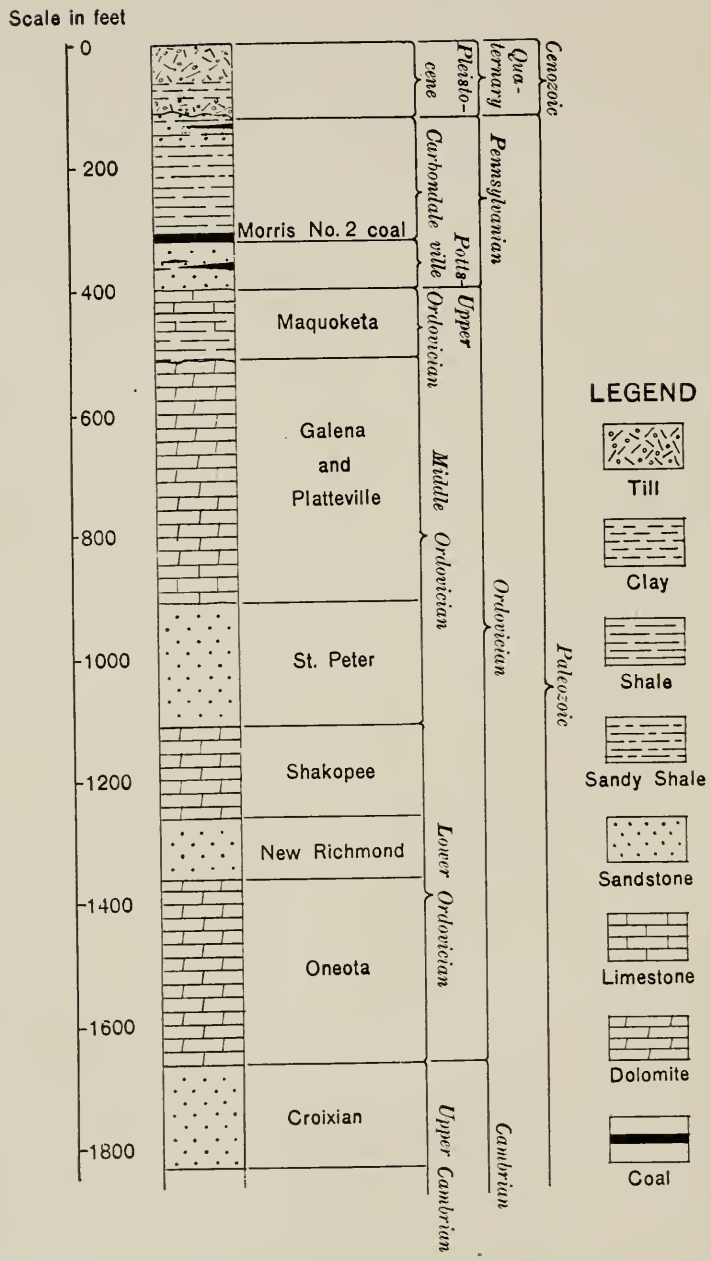

Fig. 14. Generalized columnar section of the rocks of the Morris Quadrangle

wells an abundant flow of water under high pressure was obtained, but that of the first well ceased after many years, probably on account of clogging of the well by caving matter.

Log[a] of an artesian well on the farm of Abe Hoge, NW. ¼ NW. ¼ sec. 25, T. 34 N., R. 6 E.

(Well drilled in 1875)

Description of strata	Thickness *Feet*	Depth *Feet*
Pleistocene and Recent		
Soil	50	50
Pennsylvanian		
Soapstone	8	58
Sandstone; soapstone	70	128
Ordovician		
Galena-Platteville		
Limestone	200	328
Shale	2	330
St. Peter		
Sandstone	200	530
"Cement" and shale	8	538
Sandstone	60	598
Prairie du Chien		
Limestone, white	185	783
Sandstone, white	93	876
Limestone, white	326	1202
Cambrian (?)		
Sandstone, red	166	1368
Limestone, gray	30	1398
Sandstone	317	1715
Limestone, gray	43	1758
Sandstone	163.5	1921.5

[a] Log kindly furnished by Mr. Abe Hoge, Sr., of Morris.

The Cambrian system has been penetrated east of the quadrangle near Minooka, west of the quadrangle near Marseilles, and at Streator. Comparison of these logs with those from Ottawa, Joliet, Lockport, Aurora, Batavia, and Argo, suggests that the Cambrian of the Morris region may be subdivided into three members, an upper sandstone about 200 feet thick, a middle member comprising shales and sandstones with thinner interbedded limestones about 300 feet thick, and a lower sandstone more than 200 feet thick.

The difficulty of recognizing the base of the overlying Lower Ordovician rocks introduces an element of uncertainty in the conclusions regarding the Cambrian. However, the data from the Hoge boring accord well with the succession in other parts of Illinois, as well as generally throughout the Upper Mississippi basin. The name "Potsdam," formerly applied to this whole series of beds and still in common use, should be dropped, and Croixan substituted.

On the basis of the above correlation, the Cambrian has a general southeasterly dip of about 14 feet to the mile.

Ordovician System

Rocks of Ordovician age underlie all of the quadrangle. North of the "Coal Measures" area all outcropping beds belong to this system, which elsewhere is found below the Pennsylvanian. The same general relations obtain west of the quadrangle as far as the La Salle anticline. To the east, however, these strata pass beneath Silurian beds which outcrop prominently near Joliet.

The system is subdivided into three series: the Lower Ordovician, comprising the Prairie du Chien; the Middle Ordovician, including the St. Peter sandstone, the Platteville limestone, and the Galena dolomite; and the Upper Ordovician, here represented by the Maquoketa formation. The greatest measured thickness of Ordovician in the Morris quadrangle is 1,212 feet at Coal City, but since the full thickness of Maquoketa is not there present, and since the Cambrian rocks were not penetrated, the maximum thickness is probably between 1,300 and 1,400 feet.

LOWER ORDOVICIAN SERIES

The Lower Ordovician series, formerly known as the Lower Magnesian[3] and later renamed the Prairie du Chien[4], comprises three formations, to which in ascending order, the names Oneota, New Richmond, and Shakopee have been given. With the exception of the uppermost beds of the series, these strata are but little better known than those of Cambrian age, since they are seldom reached by the drill. There are only four available records from the Morris quadrangle although there are as many more from contiguous areas. Comparison of these logs shows the presence in this area of representatives of the three major divisions of the group as listed above.

The lowest formation, the Oneota, is usually logged as white limestone, although it is dolomite. It is 326 feet thick in the Hoge well and more than 346 feet at Coal City where it is reported to include more than 150 feet of sandstone in the lower middle portion.

The next formation above is the New Richmond sandstone. Drill cuttings of this rock show it to be in most places clean white standstone similar to the well-known St. Peter formation with which it has been confused not infrequently in drilling operations. It is separated from the St. Peter, however, by more than 100 feet of dolomite, and hence can be distinguished usu-

[3]Owen, D. D., Ex. Doc. 239, 26th Cong. 1st Sess., p. 17, 1840.

[4]Grant, U. S., and Burchard, E. F., U. S. Geol. Survey Geol. Atlas, Lancaster-Mineral Point folio (No 145), 1907.

ally by position. Careful comparison of the sand grains will also in most cases make the distinction possible as the grains of the New Richmond are somewhat larger. Although in the records for this quadrangle this is a pure sandstone formation, the predominance of limestone recorded in the log of the Peddicord well north of Marseilles suggests the probability that interbedded limestones exist in the New Richmond formation in places. This accords with its character in the vicinity of La Salle.[5] The formation is 113 feet thick at Coal City, and 93 feet in the Hoge well.

The uppermost formation of the Prairie du Chien series outcrops in various parts of the State, and hence is better known than the underlying strata. It is dolomite of light color, usually gray or buff, mainly fine grained but showing coarse granular texture and marked porosity in places. This coarse phase together with the thin interbedded sandstones, account for the formation being sometimes incorrectly reported in drill logs as sandstone.

In the Hoge well it is recorded as white limestone, 185 feet thick. The Morris city well shows it to be light-gray dolomite, rather dense in texture, thickness not known. Four miles to the southeast a well on the John Holderman farm records 27 feet in limestone belonging to this formation, and at Coal City the total thickness of this stratum, described as sandy limestone, is 125 feet.

Just east of Coal City, at Braidwood, it is reported as a formation composed of white limestone and gray shale which was penetrated for a depth of 45 feet. More clastic material, both shale and sandstone, appear in this zone as it is traced northeastward, as much as 50 feet of shale appearing at the top in wells near Joliet.

MIDDLE ORDOVICIAN SERIES

This series, like the foregoing, has three formations which underlie most if not all of the Morris quadrangle. The lowest formation, the well-known St. Peter sandstone, is recognized readily by drillers and serves as a datum plane from which reasonably accurate stratigraphic measurements may be made on well logs. The other two formations, the Platteville limestone and the Galena dolomite, are indistinguishable in this region since only the latter outcrops and no criteria for the recognition of the contact of the two in drill logs have been developed. This portion of the series is therefore referred to as the Galena-Platteville formation in this report. The measured thickness for this series in the quadrangle ranges from 470 feet in the Hoge well to 581 feet in the Morris city well No. 2. Figures for the latter may be slightly in error but their approximate accuracy is indicated by a recorded thickness of 550 feet in the Coal City well.

[5]Cady, G. H., Geology and mineral resources of the Hennepin and La Salle quadrangles: Ill. State Geol. Survey Bull. 37, p. 35, 1919.

ST. PETER SANDSTONE

Outcrops of this formation west of the quadrangle in La Salle County show it to be sandstone of unusual purity. It is composed of well-rounded quartz grains which are in places but slightly cemented and in places firmly held together. Drill cuttings are nearly always composed of loose grains. While the upper and lower portions are stained to a greater or less degree and hence appear yellow or brown, black or blue, the formation as a whole is almost snow-white. This, taken with the rather uniformly small size of grain, serves as a means of ready identification in drilling. The formation is nearly devoid of fossils so that this common means of recognition of beds is not available.

The St. Peter sandstone is encountered in the Morris quadrangle at depths ranging from less than 125 feet to about 600 feet. This wide range is due in part to the inequality in the amount of cover of surficial materials, and in part to difference in altitude of the surface of the sandstone. This difference in altitude is itself due largely to the southeast dip of the formation, but probably in part also to erosional irregularities in the surface of the rock.

A table is appended giving these data and also the elevation of the surface above sea level, the thickness where known, and the character of the strata above and below.

The thickness of the formation is about 200 feet, but considerable variation is shown in logs. From the few data at hand it is not clear that the variations are due to a uniform or widespread thickening and thinning of the bed, since the fortuitous disposition of the wells may show variations due merely to erosional irregularities of the upper surface in conjunction with similar irregularities of the upper surface of the Shakopee dolomite below. If the last two factors are compensating, the Coal City and Holderman wells indicate that the formation is thinner in the southeast part of the quadrangle. An extension of this area to the northeast would include the thin part at the Minooka "oil well," on DuPage River, where only 110 feet of St. Peter was recorded. That this is a belt rather than a wide area of thinner sandstone is indicated by a thickness of more than 200 feet at Braidwood, farther to the southeast. In this connection it is of interest to note that in the area of outcrop of the St. Peter formation west of the quadrangle, there is no evidence of erosional irregularities in the surface of the formation of more than 40 or 50 feet.[6]

Since all data on the St. Peter formation in the Morris area are from well logs, but little can be said of the contact of this formation with those above or below. In a few instances drillers have noted peculiarities at the upper surface which are of interest.

[6]Cady, G. H., Structure of the La Salle anticline: Ill. State Geol. Survey Bull. 36, p. 106, 1920.

TABLE 3.—*Tabulated well data on St. Peter sandstone for Morris Quadrangle.*

Location		Depth	Elevation	Thickness	Contact with adjacent beds	
Township	Sec.				Above	Below
KENDALL COUNTY						
Big Grove (T. 35 N., R. 5 E.)	24	123	547	.....	3 ft. flint.....	.....
	24	200	480+	.....	.....	.....
	27	181	544	.....	181 ft. drift.....	.....
La Salle (T. 34 N., R. 5 E.)	32	360	360	195	25 ft. limestone.....	limestone
GRUNDY COUNTY						
Nettle Creek (T. 34 N., R. 6 E.)	3	170	450	.....	"common surface".....	.....
	5	176	489	.....	47 ft. Pennsylvanian...	.....
	10	180	425	.....	10 ft. limestone.....	.....
	13	205	395	.....	91 ft. limestone.....	.....
	13	255−	330+	.....	185 ft. limestone.....	.....
	14	198	407	.....	40 ft. Platteville + 49 ft. Galena.....	.....
	15	190	410	.....	76 ft. limestone.....	.....
	20	214	411	.....	44 ft. limestone.....	.....
	23	255	330	.....	139 ft. limestone.....	.....
	23	238	347	.....	53 ft. soapstone + 74 ft. limestone (Galena)	.....
	23	240	345	.....	125 ft. limestone.....	.....
	25	330	260	268	2 ft. clay; 8 ft. shale 60 ft. from base.....	white limestone
	26	256	339	.....	116 ft. limestone.....	.....
	32	268	350+	.....	?	?
Saratoga (T. 34 N., R. 7 E.)	12	350	210	.....	.....	.....
	18	250	330	.....	140 ft. limestone with clay pockets at base..	.....
	19	244	321	.....	154 ft. limestone.....	.....
	20	100	368	.....	.....	(of doubtful accuracy)
	24	380	155	.....	limestone.....	.....
	30	281	279	.....	168 ft. limestone.....	.....
	30	316	244	.....	limestone.....	.....
	30	233	327	.....	133 ft. limestone.....	.....
	30	278	271	.....	limestone.....	.....
	31	287	263	.....	limestone.....	.....
	32	318	227	.....	1 ft. black clay.....	.....
	35	344	181	.....	limestone.....	.....

TABLE 3.—*Tabulated well data on St. Peter sandstone for Morris Quadrangle*—Continued.

Location		Depth	Elevation	Thickness	Contact with adjacent beds	
Township	Sec.				Above	Below
Aux Sable (T. 34 N., R. 8. E.)	9	322	263	.....	limestone (?).....	?
	10	549	50	.....	90 ft. limestone.....	.....
	30	263	262	.....	limestone (?).....	.....
Erienna (T. 33 N., R. 6 E.)	3	290	305	.....	80 ft. limestone.....	.....
	4	294	316	.....	limestone.....	.....
	8	260	340	.....	105 ft. limestone.....	.....
	10	296	284	.....	limestone.....	?
	13	363−	137+	.....	limestone.....	.....
	15	443	47	.....	?	?
	15	217	283	.....	limestone.....	.....
Norman (T. 33 N., R. 6 E.)	22	374	221	.....	(?) 18 ft. clay (pocket?)	.....
	22	400	200	.....	limestone.....	.....
	22	391	210	.....	limestone.....	.....
	27	409	196	.....	"gumbo" over 1 ft. rock	.....
Morris (T. 33 N., R. 7 E.)	4	317	203	.....	?	.....
	4	316	204	.....	limestone.....	.....
	4	315	205	.....	limestone.....	.....
	4	330	193	.....	shaly limestone.....	.....
Goose Lake (T. 33 N., R. 7 E.)	12	600+	−50	.....	?	.....
Goose Lake (T. 33 N., R. 8 E.)	18	504	31	175	limestone.....	.....
Mazon (T. 32 N., R. 7 E.)	10	554	16	.....	?	.....
Braceville (T. 32 N., R. 8 E.)	3?	600	−40	150	limestone.....	.....
WILL COUNTY						
Channahon..... (T. 34 N., R. 9 E.)	6	440	?	110	limestone.....	30 ft. gray shale
Reed (T. 32 N., R. 9 E.)	8	645	−75	210	limestone.....	limestone with green shale

Inspection of the preceding table shows clay, recorded variously as "black clay," "gumbo," "clay pocket," etc., in four wells so arranged as to suggest that their geographic relation has no significance. The three feet of flint from one well may be interpreted, in the absence of samples, as a silicified phase of the overlying Platteville limestone, or as an especially well cemented upper part of the St. Peter sandstone itself. In two cases, both a short distance west of the north end of the quadrangle, the covering is loose, surficial material indicating a removal of the overlying bed rock in that region.

In the logs of the six wells passing through the St. Peter sandstone none records any peculiarity at the sandstone-dolomite contact below.

Sufficient data are at hand to show with fair accuracy the contour of the upper surface of the formation, but the delineation of the lower surface can not be attempted. For a distance of 25 miles in a general east-west line, however, the decline of the upper surface eastward amounts to 435 feet, or 17.4 feet per mile. The lower surface slopes 450 feet in the same direction, or at the rate of 18 feet per mile. It appears therefore that the dip of the formation must be of approximately this amount. The maximum slope, however, appears to be to the southeast (see contours on Plate III), in which direction it amounts to more than 28 feet per mile. From the data cited above, this is probably near the true dip of the formation.

PLATTEVILLE LIMESTONE

Above the St. Peter sandstone over most if not all the Morris quadrangle lies the Platteville limestone. This formation is characteristically non-magnesian in contrast to the other calcareous members of the Ordovician and Silurian systems which are largely dolomitic. This member does not outcrop in the region, however, and its probable character here must be determined from exposure elsewhere. Because of its lithologic similarity to the overlying member of the Ordovician, the Galena dolomite, drillers do not usually distinguish the two formations. Examination of drill cuttings renders the identification of the Platteville possible in some instances. It is customary, on account of their similarity, to place the two formations together as the Platteville-Galena. In the records of four borings, from two of which samples of drill cuttings have been examined by members of the Survey, it is possible to reach tentative conclusions regarding the Platteville. These data are presented in tabular form below, and a generalized section of the Platteville[7] is appended for comparison.

Lithologically there is considerable similarity in these sections. In each case the Galena is represented by a considerable thickness of material of uniform character, while the lower portion of the record shows variation in composition in relatively short distances. This difference in character of

[7]Grant, U. S., and Burchard, E. F., U. S. Geol. Survey Atlas, Lancaster-Mineral Point folio (No. 145) p. 4, 1907.

TABLE 4.—*Tabulated data on the Platteville limestone*

Formation	Sec. 14, T. 34 N., R. 6 E.		Sec. 4, T. 33 N., R. 7 E.		Sec. 28, T. 32 N., R. 7 E.		Sec. 25, T. 33 N., R. 9 E.	
	Strata	Thickness	Strata	Thickness	Strata	Thickness	Strata	Thickness
		Feet		*Feet*		*Feet*		*Feet*
Galena	solid limestone	49	dolomite	130	hard limestone	216	limestone	242
Platteville	brown seam	3	?	30	soft limestone	60	shale	3
	solid limestone	21	limestone	5	.....	.....	limestone	25
	soft limestone	1	?	50	hard limestone	12	dolomite	35
	limestone with soft seam	15	dolomite	5	.....	.....	.....	.....
St. Peter	sandstone	20+	sandstone	200+	sandstone	87+	sandstone	165+

Generalized section of Platteville from southwestern Wisconsin

	Feet
Limestone, principally in thin beds, and shale	10—15
Thin-bedded, brittle, fine-grained limestone	15—25
Thick-bedded, magnesian limestone or dolomite	15—25
Blue shale, at some places sandy	1—5

material, indicating changed conditions of sedimentation, is suggestive of a difference in age, and the lower beds are tentatively assigned to the Platteville.

On this basis the Platteville formation in this region includes a limestone phase, possibly with some shale above and a dolomitic phase below. The basal sandy shale, which typically is sharply delimited by the overlying calcareous beds but grades into the St. Peter sandstone below, was apparently not distinguished by the drillers in the cases cited above. In some other instances, however, there is noted a blue shaly phase, commonly recorded as the "blue St. Peter," at the contact of St. Peter sandstone and the overlying beds. It is possible that this phase is present in most places, but is not recognizable in the drilling records.

As indicated in the discussion of the St. Peter sandstone, the data from this region are in harmony with the conception of an unconformity accompanied by erosional irregularities of surface between that formation and the Platteville. A similar relationship between the Platteville and the overlying Galena is suggested but not proved by the data from this region.

GALENA DOLOMITE

The top member of the Middle Ordovician is the oldest formation exposed in the Morris quadrangle. It is the dolomite which outcrops in several places north of the "Coal Measures" area. At no point is an extensive section exposed and the paucity of outcrops makes impossible the accurate correlation of such beds as do appear. The general character of the formation can be determined, but the relative amounts of the different kinds of beds can not. One of the most extensive outcrops is in the extreme northwest part of the quadrangle on the headwaters of Saratoga Creek, in sec. 36, T. 35 N., R. 6 E. Here, for a distance of about 400 yards on each side of the wagon bridge, the stream has cut a shallow channel in the resistant dolomite, which at this place has a thin cover of loose material.

The rock is finely crystalline to earthy in texture. Although probably gray when fresh, the exposures show a buff color, with pinkish tone in places. On more complete weathering the rock becomes a yellow-brown porous mass in which are irregularly shaped pockets containing small crystals of calcite. The presence of small stringers of calcite and of small areas (one-half a square inch in size) in which uniform orientation of cleavage planes obtains, indicates recrystallization subsequent to deposition.

Yellowish-white to white chert is not rare, being apparently confined to the bedding planes. The rock is thin-bedded, especially in the upper, more weathered portion, 4 inches being the maximum thickness observed. In the outcrop probably less than 15 feet of strata are exposed, although the uniform character of the beds makes this determination doubtful. Above

the bridge the dolomite shows a low downstream dip for about 100 yards, but elsewhere is apparently quite flat. A shallow gully some rods to the east exposes about 6 feet of dolomite which there shows a southwest dip of about 1°. The very limited outcrop gives no suggestion as to the distance over which this structure is maintained. Jointing is prominent locally, the better developed planes trending N. 56° W. These have been the site of pronounced weathering in places, giving bands of yellow clay residue as much as 2 inches wide. The formation is here sparsely fossiliferous. A few crinoid segments, one flat-valved brachiopod, a mold of a straight cephalopod, and numerous fragments of the coral, *Columnaria officinalis,* are all that have been seen.

From lack of marked irregularity in the surface of the dolomite over the whole exposure, planation by glacial action is suggested. Although the exposure shows wear by streams rather than by ice, two small patches have smoothed and striated surfaces. On these two the grooves and striations trend uniformly S. 56° W.

An exposure of about equal stratigraphic thickness is found in the abandoned quarry on the north outskirts of Lisbon village. Here the following section is obtained:

Section of Galena dolomite in abandoned quarry near Lisbon	Thickness *Ft.*	*In.*
Soil, gray black	..	10
Clay, gray brown	1	2
Dolomite, well weathered, light yellow brown (crumbles easily, variable thickness)	3	6
Dolomite, cream gray, more regular bedding and jointing	5	6
Dolomite, probably same as above, but discolored from long submergence	3	0

Lithologically the rock is quite like that previously described. While much greater variation in texture and color is to be seen, it seems to be due to differences developed in weathering. No color or texture appears to be confined to any one bed or group of beds. Only slight traces of fossils were noted, mainly crinoid segments, although a loose fragment showed *Dalmanella testudinaria.* In this nearly circular quarry, about 60 feet in diameter, the beds are flat-lying.

Two and one-half miles east of this quarry, in section 21 of Lisbon Township, another opening in the Galena has been made. The operation of this quarry in 1920 exposed the following section:

Section measured in sec. 21, Lisbon Twp.	Thickness *Feet*
Drift	1
Dolomite, weathered, buff (thickness 2-10 feet)	5
Dolomite, more slabby than above, buff	5
Dolomite, fresh, pinkish gray, finely crystalline	5

In the beds exposed there are no marked differences except those due to weathering. The pink tone is very faint in the fresh rock, which is distinctly gray. From it are derived by weathering various cream, buff, brown and green tints in great irregularity. The upper beds show the same weathering effects as were described for the Lisbon quarry, but here the depth to which the weathering has progressed is less uniform. Relatively fresh rock appears at the surface at the north end of the quarry, while at the south end an advanced stage of weathering has extended to a depth of 10 feet. In the fresher part the bedding planes are about 8 inches apart.

These beds show no sets of joints but instead are broken by a few irregularly disposed cracks, essentially vertical. The greater abundance of these in places is probably related to the variation in depth to which weathering has progressed. Clay seams filling these joints to a depth of 10 to 12 feet are common.

Careful examination reveals a few fossils. Without exception the calcium carbonate has been leached from the shells, leaving casts and molds. In this connection it is of interest to note the presence of crystals of calcite up to 2 inches in diameter in the rock, but not evidently filling cavities The fossils are listed below:

Fossils from the Galena dolomite collected in sec. 36, T. 35 N., R. 6 E.

Ambonychia sp. cf. affinia
Liospira sp. cf. vitruvia
Lophospira sp.
Murchisonia sp.
Receptaculites oweni
Rhynchotrema increbescens
Trochonema sp. undescribed cf. stroporallus

In the abandoned quarry at Central (fig. 15), a little more than a mile to the south, only the upper 5 feet can be examined. The rock dump, however, shows finely crystalline, pinkish-gray rock, weathering buff, with iron stains and considerable calcite, and also bluish-gray rock which has a distinctly pink tone in some places. The texture of the two is identical, being in part massive and in part finely crystalline. It is probable that the darker rock comes from the lower part of the quarry, which is reported to be 35 or 40 feet deep. In that case it is likely that the upper rock is merely the weathered equivalent of the lower. This relation is similar to that noted for the quarry to the north. One distinction between these exposures is the depth to which weathering has advanced. In the quarry to the north an advanced stage has been reached at a depth of 10 feet and all calcite of shells has been removed. Here relatively fresh rock appears at the surface on all sides and the fossils show no leaching. A related feature of difference is the fact that in the latter case the surface has been planed off by the ice, while in the former this is not evident.

The fossils include the following:

Fossils from the Galena dolomite in the old quarry at Central in sec. 28, T. 35 N., R. 7 E.

Eccyliopterus sp.
Leptaena rhomboidalis
Orthis plicatella
Refinesquina alternata
Trochonema (?) sp.
Zygospira recurvirostra

Other exposures of essentially the same type of rock are in a run three-quarters of a mile west of Central on the north line of section 32 and in an abandoned quarry 1½ miles east on the east line of section 34.

Fig. 15. Quarry in Galena dolomite at Central, Kendall County

But three other exposures of this formation have been noted in the Morris quadrangle. In section 24 of Saratoga Township (T. 34 N., R. 7 E.) there is an abandoned quarry south of Ridge Road. The rock here is of gray-brown color, fine to medium-fine crystalline texture, and contains considerable pyrite in small grains. On weathering, an irregular surface and a marked rusty spotting is developed. The beds are sparsely fossiliferous. About a mile to the northeast, in section 18 of Aux Sable Township (T. 34 N., R. 8 E.), Collins Run exposes Galena dolomite at the wagon bridge near the Walley School. Not more than two feet of beds are exposed and they show no distinguishing characteristics. The rock is gray, near tan on some surfaces, and has a faint pink tone in others. Weathering brings out the pink color and produces also a yellow-brown stain, which is pronounced along joint planes and in cavities. Some calcite is present,

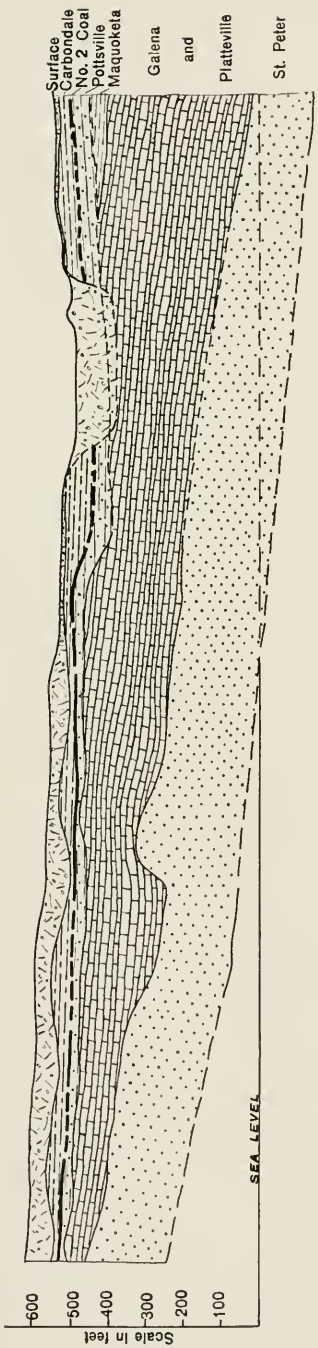

Fig. 16. Profile and structure section A—A′ (Plate III) across Morris Basin from sec. 24, Nettle Creek Twp., to sec. 20, Goose Lake Twp.

but not as much nor in as large masses as in the Central quarry beds. Fossils are neither rare nor abundant. Those gathered include:

Fossils from the Galena dolomite in sec. 18, T. 34 N., R. 8 E.

Bellerophon species
Illaenus americanus (?)
Lophospira sp.
Orthoceras sp.
Rhynchotrema increbescens

The most southeastern outcrop of the formation is in the bed of Aux Sable Creek in sec. 19, T. 34 N., R. 8 E., north of the Rock Island tracks. This comprises several isolated patches of rock smoothed by glacial action but with that surface largely modified by later stream action. The fresh rock is not exposed but seems to be gray dolomitic limestone, finely crystalline to dense in texture. It has a gray to dirty white surface color and weathers to buff below. Pyrite is rather common throughout the beds, giving rise to a "pockety" surface through weathering and stream wear. From these outcrops there appear to be two phases of the formation represented. A lower, more pyritiferous part, and an upper part comprising more fossiliferous beds. There is no indication from these outcrops of the area over which these phases are distinct. The only fossils noted were *Rafinesquina alternata* and *Delmanella testudinaria.*

The beds at this place appear to have a slight dip to the northwest.

Logs of wells in the Morris area show a much wider distribution of the Galena-Platteville formation than is indicated by the outcrops. In fact, every section in the quadrangle shows some portion of this formation, although covered by other strata in most places. Its probable presence beneath valley fill in the Illinois valley will be noted in connection with the Pennsylvanian (fig. 16). The only additional lithologic data obtained from a study of logs have reference to certain features which probably are common throughout the formation but of local rather than widespread development. These include such variations from the normal dolomite as soft bands from a few inches to several feet in thickness; chert bands; thin sandy phases; and cavities or pockets commonly lined or filled with clay. Some of these cavities are several feet in diameter and probably are the result of solution. Pyrite is common in the formation but has no apparent restriction to any zone.

As a result of the combination of several factors, the thickness of the Galena-Platteville formation ranges from 400 feet to less than 100 feet within the quadrangle. Sufficient data are not at hand to delineate the surface in detail, but an inspection of well logs brings out the relationship of the several factors to the known variation in thickness.

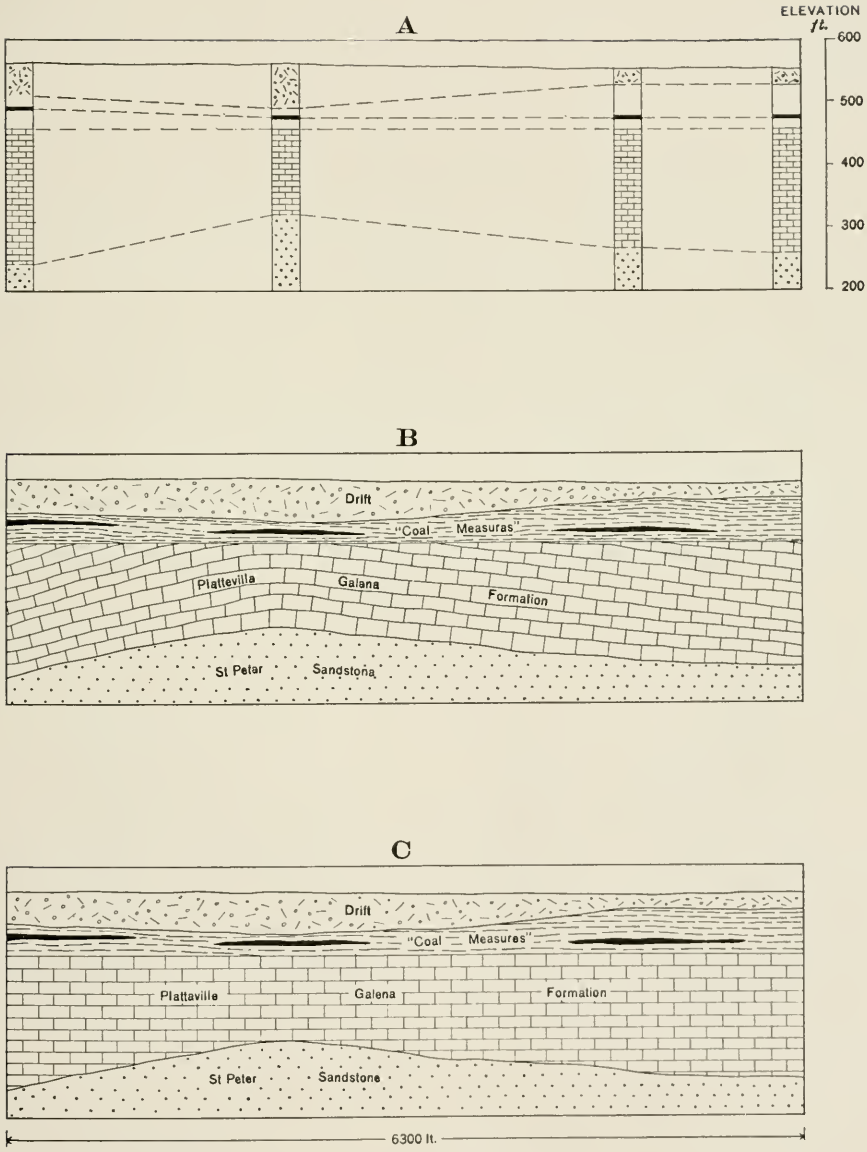

Fig. 17. Underground relations in southwestern Saratoga Township, Grundy County

The thickest part is in the Coal City region, and from there northwestward the formation thins so that a short distance west of the limits of the quadrangle the underlying St. Peter is the uppermost bed rock. This variation, amounting to nearly 100 per cent of the total thickness, is due to plantation of the formation, which has a slight tilt to the southeast. Another variation, more pronounced because of the small area involved, is in the southwest part of Saratoga Township (34 N., 7 E.). Here a group of wells shows thicknesses ranging from 216 down to 133 feet in one square mile (fig. 17A). Since the upper surface of the formation shows but 10 feet of relief in this area, the observed variation in thickness is caused by the unevenness of the lower surface. Consideration of the structure of the St. Peter formation over the quadrangle leads to the inference that this variation is the result of planation of the beds where upwarped (fig. 17B). By an alternative interpretation of these data the indicated relief of the sandstone surface suggests a measure for the difference in original thickness of the overlying calcareous series (fig. 17C).

There are also variations clearly due to unevenness of the upper surface. Thus in the city of Morris wells show a distinct rise of the surface of the dolomite northwest of the Illinois which corresponds only roughly to the increase in thickness in that direction.

One other factor, the effect of which can not be definitely stated, is that involving the Platteville formation as a unit. Too little is known of this formation to warrant other than very general deductions as to its thickness or the amount of erosion it suffered before the deposition of the overlying Galena. It is probable, however, that whatever relief was developed on its surface was compensated by a corresponding inequality in deposition of the Galena.

The absence of records showing the elevation of both the top and bottom of the Galena-Platteville, in an area where it has not obviously suffered erosion, precludes any inference as to the structure of this formation. It may therefore be assumed to have a structure similar to that of the underlying St. Peter sandstone.

UPPER ORDOVICIAN SERIES

In the Morris quadrangle, as elsewhere in Illinois, the Upper Ordovician series is represented by but one formation, the Maquoketa, which is considered to be of Richmond age.

MAQUOKETA FORMATION

Exposures of the beds of this formation are limited to the northeast part of the Morris area. One group of exposures is to be seen from the Grundy County line northward beyond the limits of the quadrangle, in the

bed and low banks of Aux Sable Creek (fig. 18). Because of the low relief of the region and the nearly horizontal attitude of the beds, only a limited stratigraphic section can be measured in the whole distance.

Another group of exposures is in the vicinity of the head of Illinois River, including the southeast part of Aux Sable (T. 34 N., R. 8 E.) and

A

B

Fig. 18. Aux Sable Creek at Shurtliffe Bridge, Kendall County
A. Maquoketa limestone in bed of creek
B. Ponding of creek above outcrop shown in A

the northeast part of Goose Lake (T. 34 N., R. 8 E.) townships. The outcrops, with one unimportant exception, are the tops of low rock knolls which here and there protrude through the thin cover of later deposits, so that but little knowledge can be added to the stratigraphy as determined from the Aux Sable Creek section.

The exposed rocks include beds of calcareous shale and of impure as well as of relatively pure limestone. The shale is thin-bedded, mainly without grit, light to dark gray, and weathers to a flaky incoherent mass. Consequently it is seen only where protected by a capping ledge of limestone. The limestone shows considerable variety of texture from dense to coarse-grained. Medium-gray when fresh, it develops a buff to brown weathered surface which effectually conceals both textural and color distinctions between beds in most exposures.

Characteristically this formation contains an abundance of fossils, including crinoids, bryozoans, brachiopods and trilobites, but some strata are practically devoid of organic remains. This lack is especially noticeable in the shale phases.

All beds of this formation appearing along Aux Sable Creek within the quadrangle are represented in exposures in section 3 of Aux Sable Township (T. 34 N., R. 8 E.). A total of 17 feet of strata are exposed in the outcrop near the wagon bridge. The section follows:

Section of Maquoketa beds exposed along Aux Sable Creek

		Thickness *Ft.*	*In.*
14.	Limestone, coarse,[a] gray brown, no fossils, stylolitic	..	6
13.	Limestone, coarse, grayish brown, fossils common, beds 10 inches thick	2	6
12.	Limestone, medium coarse, gray, fossils less common than above	4	0
11.	Limestone, slightly finer than No. 12, tan, few fossils, slabby on weathering	1	6
10.	Limestone, medium fine, gray tan, fossils abundant, usually includes a 2-inch shaly layer about 1 foot above base	1	6
9.	Limestone, medium coarse, gray, fossils abundant on bedding planes	1	6
8.	Limestone, shaly, thin bedded, somewhat uneven but persistent	..	2
7.	Limestone, medium coarse and like No. 9	2	6
6.	Shale, calcareous, gray, soft, thin bedded, varies from 2 inches to	0	6
5.	Limestone, fine, nearly dense, pinkish gray, fossils abundant	0	3
4.	Shale, like No. 6	0	6
3.	Limestone, like No. 5	0	3
2.	Shale, like No. 6	0	9
	Concealed (possibly shale)	0	6
1.	Limestone, like No. 5 (base concealed)	0	3
		17	2

[a] In field examination of sediments, the texture has been classified as follows: coarse, medium coarse medium fine, fine, and dense.

The beds of the above section are readily grouped on a lithologic basis into two divisions, an upper of more or less crystalline limestone beds (Nos. 14-7) and a lower of alternating shales and dense limestones (Nos. 6-1). While the former is fairly uniform in character the latter shows considerable lithologic variation in short distances. This is due to the change in relative amounts of limestone and shale in the division rather than to the introduction of any other types of sediments. The limestone is

clearly in lenses, or in nodules of lenticular shape, so that adjacent sections bear but little resemblance to one another. In the northwest part of section 3, Aux Sable Township, the exposure shows but two 6-inch lenses in 4 feet of strata below the lowest crystalline limestone, while at the next bend upstream, 100 yards distant, the outcrop shows seven such lenses in 6 feet of beds. From this latter outcrop it is clear that the lower group may be extended to include an additional 3 feet of strata, making the total thickness exposed approximately 20 feet.

Differences in the degree of weathering of these dense limestone lenses result in marked color variations which, not being confined to certain beds, confuse rather than clarify stratigraphic distinctions.

Local up- or down-warps of these beds bring in one place the crystalline limestone beds, in another the dense limestone-shale phase to the surface, but so far as can be determined no beds stratigraphically above or below the section given are exposed. Dips as high as 5° are maintained for a few feet, but the dip in one direction is in every instance compensated by dip in the opposite direction within a short distance.

The fossil content of these beds is of great interest. A considerable number of species of crinoids, bryozoans, brachiopods and trilobites are represented in the exposures which have not yet been given the detailed study they deserve. No attempt was made in this investigation to collect fossils systematically, but the great profusion of bryozoan forms was frequently noted as a characteristic of the strata of this formation.[8] Aside from these and the crinoids, neither of which were especially studied, the more common forms were the following:

Bellerophon sp.
Calymene senarius
C. christyi
Dalmanella sp. cf. Meeki
Dinorthis subquadrata
Hebertella occidentalis
Isotelus maximus
Orthoceras sp.
Plectambonites sericeus
Pterinea sp.
Rafinesquina alternata
Rhynchotrema capax
Strophomena planaodorsata

South of the Illinois-Michigan Canal and west of the head of Illinois River there is an area in which the Maquoketa limestone is almost at the surface. In the south half of section 22 rock was met at shallow depth in digging the canal. Along the road a few rods to the south the limestone comes to the surface for a quarter of a mile. Here it has the usual pinkish-buff color on exposed surfaces. Fresh samples show this to be medium fine-grained (average less than 1 mm. diam.) relatively pure limestone, medium gray, and containing irregular veinlets of calcite. The hand lens reveals scattered grains of pyrite (one to a square inch) and less commonly small black particles of an undetermined substance. Some loose frag-

[8]Mr. C. R. Schroyer, formerly of the Illinois State Geological Survey, has studied this bryozoan fauna extensively. His report, not yet completed, describes many new forms. (Personal communication.)

ments showed the stylolitic structure noted in the uppermost beds of the Aux Sable Creek section.

About eight feet of crystalline limestone is exposed in the south bank of Illinois River in section 26 of Aux Sable Township (T. 34 N., R. 8 E.). The rock here is similar to that just described and is apparently identical with that of the upper division of the Aux Sable Creek section. The stratigraphic relationship of these beds is not determinable from the outcrops, although, as will be shown later, the Illinois River beds are probably some 30 feet higher in the geologic column than those of Aux Sable Creek.

Other exposures of this crystalline limestone are found on the south bank of Illinois River in section 25, along the road in sections 34 and 35, and are reported beneath Pennsylvanian beds on the west bank of Kankakee River in section 36. Southward toward Goose Lake, two outcrops, one in section 2 and another in section 11, reveal the presence of this limestone at shallow depths in this part of Goose Lake Township. To the west, south and east, however, it is overlain by strata of the "Coal Measures."

A characteristic of the limestone phases of this formation is the prominence of fossils on weathered surfaces. Not infrequently it is possible to find perfect specimens of *rafinesquina alternata, rhynchotrema capax* and other common forms lying loose on the exposed ledges.

Additional data both as to the extent and the lithology of the Maquoketa formation are obtained from study of drill records. The Maquoketa formation underlies the drift in a strip about four miles wide, extending northward from Illinois River. There is no trace of its former extension to the west, but it extends east beyond the quadrangle to the DuPage, where its eastward dip carries it beneath Silurian limestone of Alexandrian age. South of the Illinois there is a tongue-like projection, but slightly concealed by mantle rock, into the area of Pennsylvanian strata, terminating near the north shore of Goose Lake.

Its southward extension, where concealed by Pennsylvanian beds as well as by glacial drift, is problematical. A boring at the Goose Lake plant of the Haeger Brick and Tile Company passed through 50 or more feet of limestone and shale, probably referable to the Maquoketa. Forty-five feet of shale, referred to this formation, was met in the deep boring at Coal City, but the relation of these beds to the overlying Pennsylvanian is not clear. Even less satisfactory is the record of a boring on the Holderman farm, section 18 of Goose Lake Township (T. 33 N., R. 8 E.), where the 88 feet of "sandy shale" below No. 2 coal may include some lower Maquoketa shale.

The log of the Walker well, two miles southwest of Mazon, has been interpreted by Cady[9] as including 74 feet of shale of Maquoketa age. But

[9]Cady, G. H., Coal resources of District 1 (Longwall): Ill. Coal Mining Investigations Bull. 10, p. 119, 1915.

here, as in the Coal City log, the lack of a satisfactory horizon marker for the Pennsylvanian part of the record leaves the position of the lower shales in doubt. There must be admitted, however, the possibility that Maquoketa beds are present in the southeast part of the quadrangle. The bearing of this on the structure of this formation will be noted later in the discussion of the structure of the Ordovician beds.

Within the Morris quadrangle the Maquoketa comprises an upper limestone phase and a lower shale phase. The resistant nature of the former is revealed by the outcrops described above, but the shale phase does not appear at the surface within the quadrangle, although thin shales interbedded with limestone, as previously noted, are exposed in the Aux Sable Creek section.

The thickest part of the limestone member is near the head of Illinois River. The log of a well in section 36 of Aux Sable Township (T. 34 N., R. 8 E.) gives a measured thickness of 44 feet, but a total of 65 feet is probably present in places where the elevation of the surface is correspondingly higher. At the north boundary of the quadrangle the limestone is less than 30 feet thick, a well in the west half of section 27 of Seward Township (T. 35 N., R. 8 E.) shows but 8 feet, while less than half a mile west no limestone at all is recorded above the shale phase. This thinning to the west is obviously due to the erosion of the beds which here dip gently eastward. It is thus clear that the beds of the Aux Sable Creek section lie near the base of the limestone member which has its western limit less than a mile farther west. South of the Illinois, however, where the thickness is more than 60 feet, the outcropping beds are above that horizon by at least the difference in thickness or more than 30 feet. More accurate definition of the stratigraphic relation between these beds is not practicable with the present data.

The lithologic character of the limestone-shale phase of the Aux Sable Creek section, as well as its proximity to the western limit of the limestone member, suggests that this lower phase is the transition zone between the shale and limestone members of the Maquoketa. On this interpretation there is no unconformity between these members.

The shale member has a maximum known thickness of 65 feet, which is maintained uniformly eastward beneath the overlying limestone. West of this protecting cover it thins, extending less than a mile beyond the west limit of the limestone.

Lithologically the lower member is entirely shale, no interbedded limestones having been recorded from borings. It is usually medium to dark gray, soft, thin-bedded, non-calcareous, and without fossils.

While within the quadrangle the Maquoketa shows only the two members already described, well records farther east show an additional mem-

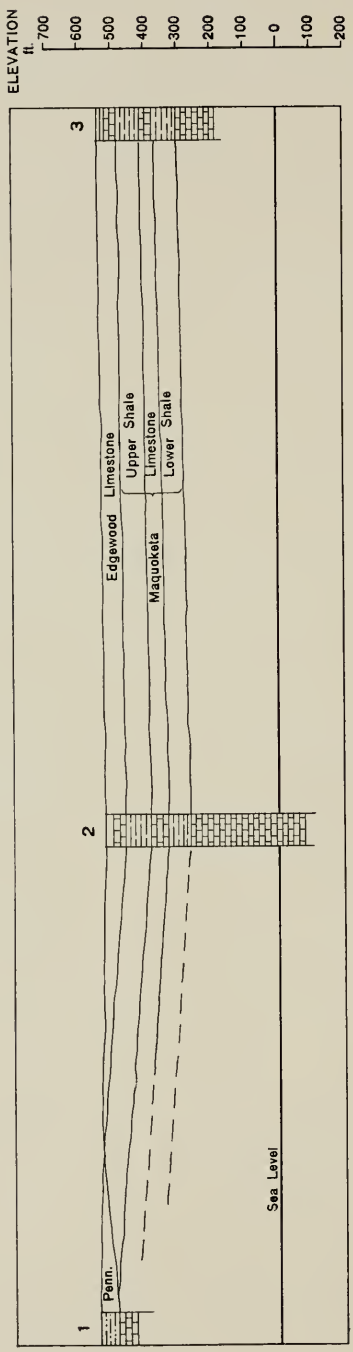

Fig. 19. Southwest-northeast section across Kankakee River near Lorenzo

1. Sec. 18, Wilmington Twp.
2. Sec. 8, Wilmington Twp.
3. Sec. 34, Channahon Twp.

ber, the presence of which has a bearing on the stratigraphy of the area under investigation.

As noted earlier, the Ordovician strata at the east side of the quadrangle have a low eastward dip which carries them beneath limestone of Silurian age. East of the edge of this limestone, as shown by all available well logs, the Maquoketa comprises two shale members, separated by a limestone. These relations are well shown by a northeast-southwest section across Kankakee River near Lorenzo (fig. 19), based on the following data:

TABLE 5.—*Logs of wells near Lorenzo, Will County, showing thickness of strata penetrated*

Formation	Strata	Section 18 Wilmington Township	Section 8 Wilmington Township	Section 34 Channahon Township
		Feet	*Feet*	*Feet*
Edgewood (Silurian)	limestone	eroded	29	33
Maquoketa (Upper Ordovician)	upper shale	eroded	76	75
	limestone	50	52	35
	lower shale	not penetrated	61	80

While the scattered wells show considerable variation in the thickness of the several members, they indicate a thinning of the limestone to the east and north, and even greater thickening of the shale, so that the formation as a whole is thicker.

Since this upper shale is 45 feet thick about a mile east of the Morris quadrangle, it is obviously probable that it extended over the Minooka area at one time, if indeed it does not now. On this point the logs are not enlightening, since the "surface," amounting to about 125 feet, is blue clay till, which might not be distinguished in drilling from the Maquoketa shale. Indeed, it is not improbable that this upper shale may have furnished much of the material of the surface till.

The relations of the Upper Ordovician beds to the overlying Silurian limestones has been noted, but the details of the contact are not involved in the present study since the latter rocks do not outcrop in the area.

With regard to the contact of the Maquoketa and the underlying Galena, but little can be said since the only data are from a small number of scattered wells. There is no indication of discordant relations nor of an erosion surface of even moderate relief. Hence it may be assumed that the contact is essentially a plane surface and represents, if not a conformity, at most merely a slight interruption in the deposition of sediments between Middle and Upper Ordovician epochs.

Elsewhere in the Upper Mississippi Valley the exposed contact of the two series shows concordant relations also, but the fossil content in most places indicates a gap in the record.[10]

Pennsylvanian System

Subdivisions of the Pennsylvanian[a]

McLeansboro:

Calcareous shales, La Salle limestone, Lonsdale limestone, sandy shales, No. 7 coal (locally important).

Carbondale:

Shaly sandstones, shales, some fine grained limestone, and coals Nos. 6, 5, and 2.

Pottsville:

Mainly sandstone and shale with some limestone and thin coals, including No. 1 (locally important).

[a] Italicized formations are represented in the Morris Quadrangle.

The rocks of the Pennsylvanian system belong to the "Coal Measures" or strata associated with beds of coal. They are the youngest solid rock formations of the quadrangle and underlie the drift over the southwestern two-thirds of the area.

Disregarding certain small outliers to be noted later, the north limit of these beds is approximately the Grundy-Kendall county line at the west and the head of Illinois River at the east. This large area, comprising some 150 square miles, probably is divided into two parts at the Illinois valley, at least in the eastern half of the quadrangle, by an old valley now almost filled with sand and gravel (fig. 16).

The presence of surficial deposits renders the exact definition of the northern boundary difficult and on Plate III the contact is placed as accurately as possible on the basis of the well logs at hand. More detailed knowledge doubtless would show greater irregularity in this line, but certain points on it are definitely fixed by exposures.

Inspection of Plate III shows the Pennsylvanian beds to overlie the Galena dolomite at the west, and the Maquoketa formation at the east, without significant difference in elevation. This relation shows that the older beds had been somewhat warped and then subjected to erosion for a period of time before being covered by the deposits of Pennsylvanian age. An examination of the geologic map of the state brings out still more clearly this overlapping of older strata by Pennsylvanian beds.

The Pennsylvanian of the Morris region belongs to a great system of strata of the same period which underlies most of the State of Illinois as well as adjoining parts of Indiana, Kentucky, Missouri and Iowa. This

[10] Grant, U. S., and Burchard, E. F., U. S. Geol. Survey Atlas, Lancaster-Mineral Point folio (No. 145), pp. 7-8, 1907.

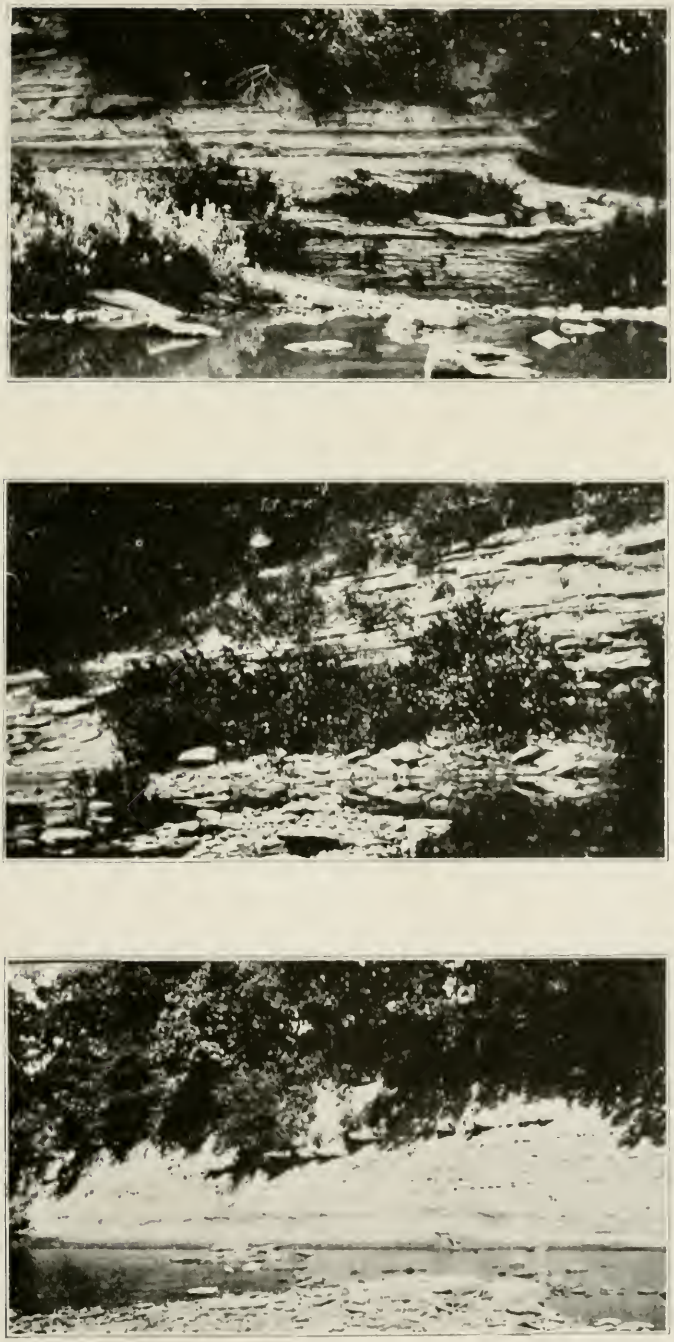

Fig. 20. Carbondale sandstone showing characteristic thin bedding and resistant lenses

whole region is known as the Eastern Interior Coal Basin in distinction from the coal areas of other parts of the United States. This great series of beds occupies a wide, relatively shallow depression, which was the site of deposition of more than a thousand feet of sediments including several valuable coal beds. The basal part of this series is made up of rocks which probably were deposited in fresh water if not in streams. Above these, however, are thin limestones containing marine fossils, which prove that at several times the basin was invaded by the sea. None of these limestones has been recognized in the Morris quadrangle, and hence the marine origin of any of the Pennsylvanian strata there may be questioned. The boundary of the Pennsylvanian beds in the Morris area is a portion of the boundary of the Eastern Interior Coal Basin and the history of the Pennsylvanian beds here, part of that of the larger area. The beds which outcrop in the vicinity of Goose Lake are essentially continuous beneath the whole basin and come to the surface again at the extreme southern limit of the basin in the area west of Shawneetown. Examination of the exposed strata in the Morris region, therefore, is of interest in connection with studies of the Eastern Interior Basin as a whole.

Pennsylvanian rocks are exposed in more or less isolated patches in most of the area which they underlie. The outcrops are almost wholly restricted to the courses of streams and hence are absent in the southwestern part of the quadrangle where the thicker drift covering has not been cut through. North of Illinois River the beds are exposed (1) on Aux Sable Creek in three places between the Rock Island tracks and the Illinois-Michigan Canal, (2) on East Fork of Nettle Creek in the city of Morris and (3) on Nettle Creek in sections 6 and 7 of Erienna Township (T. 33 N., R. 7 E.). More extensive exposures are found south of the Illinois, (1) along Waupecan Creek in Wauponsee Township (T. 33 N., R. 7 E.), (2) along Mazon River and its tributaries from Pine Bluff Bridge to the south limits of the quadrangle, (3) within the Goose Lake depression and (4) along the Kankakee from the county-line bridge to the head of Illinois River.

The outcropping beds are mainly sandstone, shale and intermediate types of rocks, with some bituminous layers, but almost no limestone.

The sandstones are variable in texture, the purer ones being rather coarse. Light gray when fresh, they show a wide range of weathering colors, buff or brown being the most common. Few beds are massive, most of the sandstones are thin-bedded, and cross or current bedding is extremely common. (See fig. 20.) Ripple-marked bedding planes are not rare. Calcareous and ferruginous concretions of nodular or lenticular shape occur at irregular intervals in the beds. (See fig. 21.) These range from minute masses to those measured in rods. In composition the sandstones show little

variation. They are composed of quartz grains with abundant mica, but without conspicuous amounts of other minerals. A calcareous cement is common, so that brisk effervescence results from the application of dilute hydrochloric acid. With increase in the amount of argillaceous matter, they grade into shaly sandstones and from those into sandy shales (fig. 22).

Fig. 21. Lenticular concretions in Pennsylvanian beds along Mazon River

These are rocks of finer texture but similar to the sandstones in color, structure and weathering effects.

The shales are of very fine texture where pure, but coarser where gritty, and in some cases have an appreciable content of calcium carbonate. In color they range from very light gray to black, being blue, green or even red in some beds. The amount of organic matter present is greater in the darker shales, reaching a maximum in the black bony layers commonly associated with beds of coal.

In thickness these beds range from less than 10 feet at the northern limit of the Pennsylvanian area to more than 200 feet farther south. This increase is not gradual, however, because of the unevenness of both upper

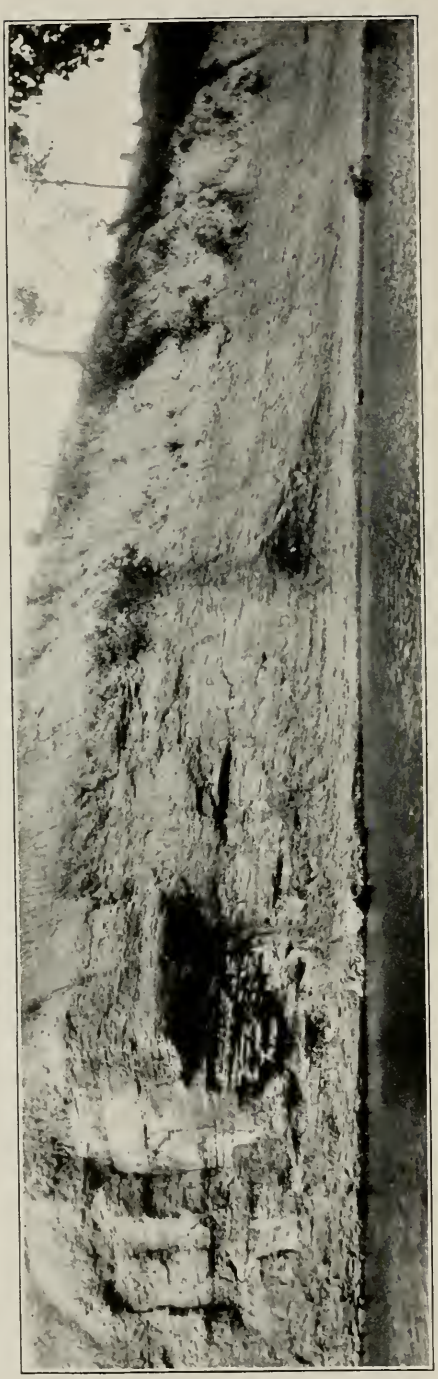

Fig. 22. Typical sandy shale of the Carbondale formation

and under surfaces. The former shows a total relief of at least 80 feet, with a maximum of 50 feet in one mile. The undulatory character of the lower surface is well shown at the contact of the Pennsylvanian and Ordovician strata on the west bank of Kankakee River. From a study of field relations of these beds in the adjoining region, it is clear that there is at least 20 feet difference in the elevation of the base of the Pennsylvanian within short distances. Well records show a similar surface in the region to the west and south. The lower surface is not known in detail south of Illinois River, because the many borings have stopped in most instances at the horizon of No. 2 coal. The unevenness of the surface of this coal is, however, suggestive of even greater relief in the sub-Pennsylvanian surface.

The rocks of this system are not abundantly fossiliferous. Locally a great profusion of forms is found, plant remains being more common than those of animals, which are restricted to certain strata, notably the well-known "fossil beds" of Mazon River. No marine fossils have been recognized and in general the fossils have not been found of stratigraphic value, and no faunal lists have been prepared. It is possible that careful study of plant remains will demonstrate the accuracy or inaccuracy of certain correlations which have been made on structural and lithologic basis.

The Pennsylvanian rocks of the Illinois basin are subdivided for convenience into three formations, which in ascending order are called the Pottsville, the Carbondale, and the McLeansboro. On the basis of an examination of the included fossil plants, David White[11] has determined that the Pottsville formation, which includes all beds below the under clay of No. 2 coal, are of approximately the same age as the Pottsville of the Appalachian fields. Similarly, the rocks of the Carbondale, including all beds between the underclay of No. 2 coal and the top of No. 6 coal are referable to the Allegheny epoch, while the McLeansboro, including the Pennsylvanian rocks above No. 6 coal, corresponds approximately to the Conemaugh formation of Pennsylvania.

These subdivisions can be recognized, at least in part, in the Pennsylvanian strata of the Morris region. The key horizon is No. 2 coal, which is quite generally present, and from which measurements can be accurately made both up and down. This coal marks the contact of the Carbondale and the Pottsville. The separation of the beds of the Carbondale from those of the McLeansboro is rendered difficult because of the absence of No. 6 coal throughout this portion of the State. Certain beds in the southwestern part of the quadrangle, associated with the stratum here called the Waupecan sandstone, are possibly to be classed in the McLeansboro.

POTTSVILLE FORMATION

Rocks tentatively assigned to the Pottsville underlie the drift in a belt from one to four miles wide lying just south of and parallel to the edge of

[11]White, David, Ill. State Geol. Survey Bull. 8, p. 268, 1908.

the Pennsylvanian area. (See Pl. III.) The variation in width of the belt is due in part to the difference in thickness of the beds and in part to the difference in their altitude. The only outcrops north of Illinois River are those of Aux Sable Creek, but south of the river the beds come to the surface at Devine, Goose Lake, and on Kankakee River, just above the head of the Illinois.

All available drill records show the presence of this formation in the area southwest of this belt, No. 2 coal being reported nowhere as resting on the underlying Galena dolomite. As was pointed out in the discussion of the Ordovician system, unusual thicknesses of shale referred to the "Coal Measures" may include some Maquoketa strata. Examination of drill cuttings is the most satisfactory method of determining whether or not the Ordovician is present, but at the present no such samples are available. The character of the strata immediately above the Galena dolomite under most of the area northwest of Coal City indicates that they are Pennsylvanian rather than Ordovician.

CORRELATION

As noted above, definite correlation of Pottsville strata is based upon the presence of the overlying coal bed, which is No. 2 of the Illinois section. In an area where No. 2 is not present, the assignment of beds to a definite zone is attended with difficulty. This is the condition at the margin of the Pennsylvanian area, where so far as indicated by their areal distribution, the strata may belong to the Pottsville, or to some portion of the Carbondale above the zone of No. 2 coal, or to the McLeansboro. While little hesitancy might be felt in assigning to the Pottsville the beds lying north of the city of Morris in this belt, since they contain no coal which could possibly be classed as No. 2, the presence of a coal bed in section 19 of Aux Sable Township (T. 34 N., R. 8 E.) and in the Goose Lake depression makes it necessary to exercise great care in the correlation of the strata in the southeastern part of the belt. Nevertheless, all these beds are tentatively assigned to the Pottsville for the reason noted in the following paragraphs:

1. Strata of undoubted Pottsville age are found a short distance south of this belt wherever the rocks below No. 2 coal have been penetrated. Since they show no thinning at the edge of No. 2 coal it is improbable that they are abruptly terminated there.

2. The lack of similarity of the strata of this belt and those of the known Carbondale area to the south suggests a difference in age. The sandy beds of the northern area are for the most part coarser and less micaceous, composed of less worn and less well assorted material.

3. The coal beds of this belt apparently are not connected with the main body of No. 2 coal. They are distinctly lenticular, pinching out on all sides, and the thick parts are more than twice as thick as the average of

No. 2 coal. The strata accompanying the coal in Aux Sable Township[12] and in Goose Lake are not like those typically associated with No. 2 bed. And furthermore, a bed of limited extent lying 20 feet below the level of No. 2 coal was mined at Jugtown at an early day.

4. Even if the Goose Lake coal be assigned to the horizon of No. 2 coal, the 75 feet of beds underlying it are thus automatically classed as Pottsville.

The thickness of the Pottsville ranges from a few feet at the north edge of the Pottsville belt to about 90 feet northeast of Morris. South of the Illinois records of but few borings penetrating beds below the Pottsville are available and these show from 33 to 75 feet of Pottsville present. North of the river 19 available logs show Pottsville thicknesses ranging from 10 to 89 feet. In general the formation is thinner at the west margin of the quadrangle, thicker toward the southeast, but in all cases thins toward the outcrop. The surface of the Pottsville ranges in elevation from more than 500 feet above sea level near the outcrop to 454 feet at Morris and to a minimum of 376 feet, two miles west of Coal City. The details of the relief of this surface are not known but there is a general slope to the top of the Pottsville toward the south and west.

Lithologically the Pottsville includes sandstones and shales with an inconsequential amount of coal in thin and locally developed beds. There are gradational types between sandstone and shale, as well as calcareous and bituminous varieties. Exposures of Pottsville beds are mainly of sandstone, although the more extensive outcrops reveal interbedded shales, which have not sufficient resistance to weathering to give rise to independent outcrops. A good section, of more than 40 feet, may be constructed from a discontinuous exposure on the Kankakee in section 1 of Goose Lake Township (T. 33 N., R. 8 E.) and in adjoining sections up and down stream. The section follows:

Pottsville section exposed along Kankakee River, Goose Lake Township

	Thickness *Ft.*	*In.*
Sandstone, shaly, thin-bedded but including abundant sandstone concretions	15	..
Shale, gray, in part carbonaceous, and black, with some black plant fragments	12	..
Sandstone, light gray, coarse grained, including a gray to black shale with abundant plant fragments	4	..
Shale, dark brown, weathering yellow and pink	1	6
Clay, light greenish gray, bedding marked by prominently jointed resistant calcareous lenses	12	..
	46	6

[12]Bradley, Frank H., Geol. Survey of Illinois, Vol. IV, p. 198, 1870.

There is an exposure of beds probably below these and possibly well toward the base of the Pottsville on Aux Sable Creek, where crossed by the Illinois-Michigan Canal. The sandstone here is gray, medium coarse in texture, and composed essentially of quartz with a sprinkling of a black mineral and fewer red and light-green grains. Mainly finely laminated with excellent ripple marks, some of the strata are more massive, in which case fine, short, carbonaceous streakings are common. Some beds are sparsely fos-

Fig. 23. Spherical concretion in sandstone on Aux Sable Creek

siliferous. A striking feature is the presence of large sandstone concretions showing prominent cross-bedding, such as were noted at the Kankakee (fig. 23).

One of the local carbonaceous phases, not rare in the Pottsville, is shown in exceptional thickness in the clay pit of the Haeger Brick and Tile Company at Goose Lake (fig. 24) where the following section appears:

Section of strata in clay pit of the Haeger Brick and Tile Company at Goose Lake

		Thickness	
		Ft.	*In.*
Black swamp beds		3	0
Coal	1 ft. 6 in.		
Clay	9 in.		
Coal	2 ft. 0 in.	5	7
Clay	10 in.		
Coal	6 in.		
"Soapstone", thickness variable		4	0
Sandstone, lenticular		2	6
"Soapstone", thickness variable		0	4
Clay, base concealed		3	0
		15	5

The same or similar coal has been dug about 200 yards to the southeast but there is no indication that either coal extends over more than a few acres.

That the Pennsylvanian system formerly extended farther north than its present limit in the Morris area is suggested by the fact that near its present margin the upper portion has been removed by erosion. This is true not only of the beds above No. 2 coal but of the beds assigned to the Pottsville as well. The earlier extension is further indicated by the fact that in

Fig. 24. Pennsylvanian beds in the clay pit at the west end of Goose Lake

small areas the present surface of the strata shows considerable variation in elevation. For example, in section 34 of Aux Sable Township, sandstone appears above the 520-foot level while the elevation of the surface for two miles north is below 520 feet. It is obviously probable that the lower land to the north was originally covered by beds contemporaneous with the 520-foot sandstone. In view of the fact that the surficial material extends down to or below the 520-foot level for at least four miles north of the sandstone exposure it is evident that the Lower Pennsylvanian beds may have extended that far.

Well records in the region are interesting in this connection. A well in the SW. ¼ section 22, Aux Sable Township (T. 34 N., R. 8 E.), showed 6 feet of "soapstone" above the Maquoketa limestone, which was at 503 feet above sea level. Wells in section 24 show the limestone surface nearly 50 feet lower, suggesting that the Pennsylvanian may have been at least that thick in this area. Wells in sections 14 and 9 of the same township showed the surface of the Maquoketa limestone to rise northward, but fragments of clean bright coal in drill cuttings from a well in the NE. ¼ section 9 prove the presence of Pennsylvanian beds at that point. Three miles north of the Morris quadrangle in section 3 of Seward Township (T. 35 N., R. 8 E.), Kendall County, four feet of coal is reported from a dug well beneath 21

feet of glacial drift. This still further extends the limit of former Pennsylvanian covering on Ordovician rocks. While well records indicate the former continuity of Pennsylvanian beds over the area immediately north of the present boundary, it is not clear that the Kendall County coal-bearing beds

Fig. 25. Exposures of Carbondale beds along Mazon River near Tieders Ford. The lower is a near view of the distant beds shown above

were connected with these by a farther northward extension, although that is the logical position for the connecting link.

The stratigraphic position of the beds forming these outliers to the Pennsylvanian area cannot be fixed. The scantiness of the lithologic data and the lack of any fossils make exact determination impracticable.

CARBONDALE FORMATION

Beds of Carbondale age underlie the drift over all of the Morris quadrangle south of the belt assigned to the Pottsville. Exposures are limited to the deeper stream channels and hence are infrequently seen north of Illi-

A

B

Fig. 26. Typical exposures of Carbondale strata on Mazon River
A. Massive sandstone at Pine Bluff Bridge
B. Thin bedded sandstone in sec. 19, Felix Twp.

nois River. Nearly 20 feet of these strata outcrop along East Fork of Nettle Creek in the northwest part of Morris, and a similar exposure appears along Nettle Creek in sections 6 and 7 of Erienna Township (T. 33 N., R. 7 E.). No outcrops appear in the channel of the Illinois, but south of the river the Pennsylvanian beds appear interruptedly along Waupecan Creek and Mazon

River. (See fig. 25.) The latter group of exposures comprises the larger section and includes all beds outcropping on Waupecan Creek.

In general the Carbondale strata are uniform over wider areas than are the Pottsville beds, as indicated by the widespread continuity of the basal

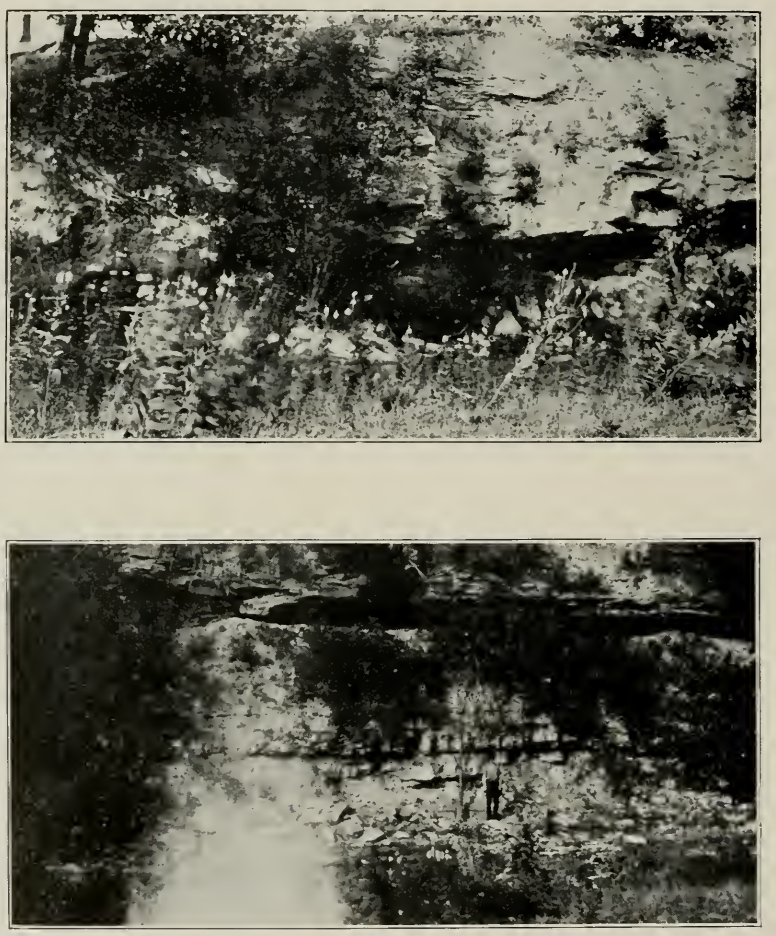

Fig. 27. Waupecan sandstone and underlying beds on Waupecan Creek. The contact is marked by the undercutting below the massive sandstone.

member, No. 2 coal. Above the coal lies a variable thickness of shale, sandy shale, and shaly sandstone with but little pure sandstone and almost no limestone. In the latter feature it differs markedly from the typical McLeansboro in which calcareous beds are prominent. The thickness of the Carbondale varies from 10 feet at the northeastern margin to about 150 feet in the deeper parts of the basin. This variation is due to a combination of factors,

the two most important being differences in original thickness and in the amount of subsequent erosion. A difference in the elevation of the surface of No. 2 coal of about 50 feet occurs two miles west of Coal City. This has been interpreted as a synclinal structure,[13] but may possibly be explained as an original inequality in the surface of the basin of deposition, since the coal here is more than 30 inches thicker than outside of the trough. In any event it causes a corresponding difference in thickness of the formation. Similar but less marked relief in the surface of No. 2 coal with corresponding variation in the thickness of the overlying beds occurs in the vicinity of Morris.

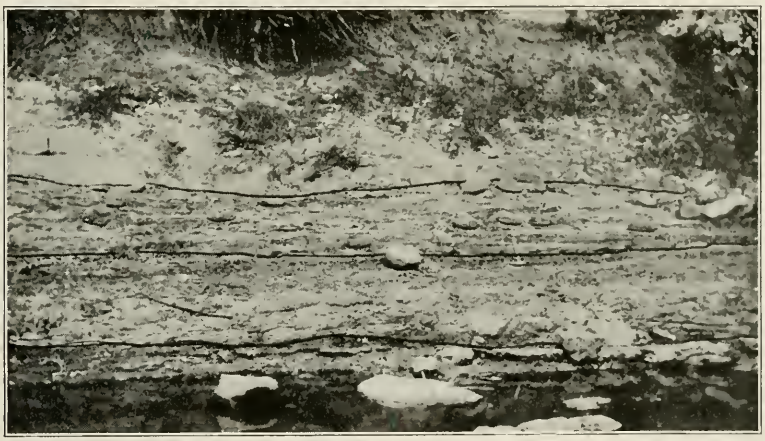

Fig. 28. Exposure showing beds below Waupecan sandstone; the shales bearing nodular limestone are at the water's edge. Mazon River, sec. 6, Maine Twp.

Although uniform in their general characters, the exposures of these rocks reveal marked lithologic differences. These are in part differences between different parts of the formation and possibly in part differences in phases of the same beds. Thus the section at Pine Bluff Bridge shows relatively massive beds of cross-bedded sandstone (fig. 26). An equally thick section a few miles upstream, as in section 19 of Felix Township (T. 33 N., R. 8 E.), shows only shales and sandy shales. Another exposure may reveal sandstone underlain by gray shales, black fissile shale or in places a thin coal bed. Similar but less marked differences appear in what seems to be the same part of the formation. Thus the plastic shales including the fossil beds of section 13, Wauponsee Township (T. 33 N., R. 7 E.), are distinctly sandy in the upstream portion in section 24, so that although apparently belonging in the same stratigraphic zone the two sections are lithologically distinct.

The details of the stratigraphy of the Carbondale formation are not readily ascertained from even such good exposures as lie along Mazon River.

[13]Cady, G. H., Coal Resources of District I (Longwall): Ill. Coal Mining Investigations Bull. 10, p. 73, 1915.

It is impracticable, therefore, to attempt to present a detailed section, although a generalized column is possible from present data. This includes the following members:

Generalized section of Carbondale formation

		Thickness *Feet*
4.	Sandstone and shaly sandstone	10—25
3.	Shale, including carbonaceous beds	15—25
2.	Sandstone and shale	65—100
1.	No. 2 coal (average)	3

Evidence is fairly clear as to the presence of at least one break in the sedimentary record of the Carbondale in this area. It is at the top of No. 3 of the above section and is marked by a distinct change in the character of deposit and possibly by an uneven contact. The base of the sandstone of No. 4 in many places clearly occupies an erosional depression in the lower beds, but in other places the relations are by no means clear. (See fig. 27.)

The section just below this stratigraphic break comprises the distinct and easily recognized group of beds which are listed below:

		Thickness *Ft.*	*In.*
6.	Shale, black, weathering to a flaky incoherent mass	3	
5.	Shale, black, fissile, with spherical pyritic concretions	2	
4.	Shale, soft, bony, grading below to black flaky shales which are gray at base	3	
3.	Sandstone, black, coarse, locally conglomeratic		1
2.	Clay, green, soft, plastic, with embedded limestone masses, nodular or lenticular	2	
1.	Shale, gray, soft, thin-bedded, base concealed	1	
		11	1

Considerable variation in the thickness of the several members is noted, but the sequence appears to be without essential variation. Figure 28 shows portions of beds 6, 5, 4, and 2, No. 3 being indistinguishable here. Portions of the fissile shale show an excellent development of cone-in-cone structure and are distinctly calcareous (fig. 29). The contact of the sandstones with the underlying shales is extremely irregular as shown in figure 30. This unevenness seems to be in part due to erosion and in part to the concretionary development both in the sandstone and in the fissile shale.

This break above No. 3 of the preceding section has been followed from the vicinity of Sulphur Springs School west and north beyond Seneca, but the heavy covering of drift prevents its exposure to the southwest. The presence of a similar section in borings near Verona suggests the continuity of these beds and the included stratigraphic break over an area of at least 100 square miles. The limited zone of beds involved in the break, however, strongly suggests a localization of the controlling conditions.

Two members of the Carbondale are thus recognized. The lower comprises No. 2 coal and the overlying sandstone and shale beds with locally developed coal at the top. Only the upper portion of this member outcrops along Mazon River, but drilling shows it to be from 80 to 125 feet thick. The upper member includes sandstone and overlying sandy shale to a thickness of 25 feet. These beds are typically exposed along Waupecan Creek and appear also on Mazon River near Sulphur Springs. It will be called the

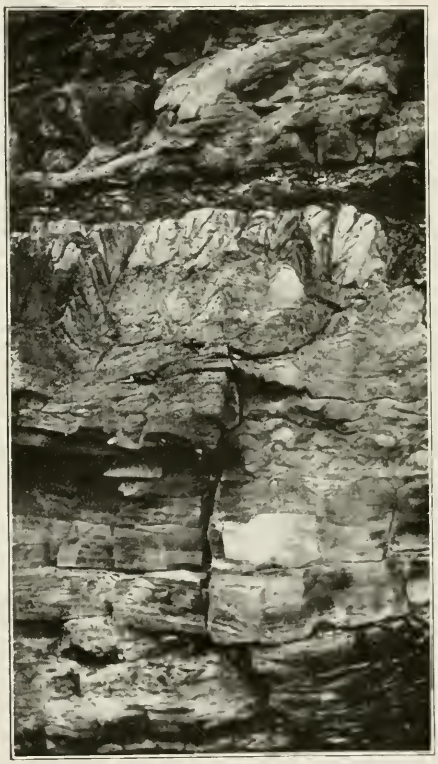

Fig. 29. Fissile shale showing calcareous phase with cone-in-cone structure. Mazon River opposite Johnny Run

Waupecan sandstone in this report. A development of "millstone" concretions is common if not characteristic of this member (fig. 31).

By definition the top of the Carbondale is marked by No. 6 coal, which is recognized by the overlying limestone stratum. In the Morris area, however, neither the coal nor the limestone marker of that horizon is present, and consequently the stratigraphic position of the upper beds of the formation as exposed in this quadrangle is somewhat in doubt. If No. 6 coal was ever laid down in this region it apparently has been removed by erosion.

Consequently the present top of the Carbondale section presumably lies stratigraphically below the horizon of No. 6 coal.

Although the Waupecan sandstone may belong to the Carbondale, as stated above, in the absence of a definite marker for the top of that series, it may also be considered to represent the McLeansboro in this region. It is clear that the correlation of these strata depends upon the correlation of the included coal beds.

As already noted, No. 2 coal, the base of the Carbondale formation, is remarkably uniform in thickness and character over wide areas. It is readily recognized by drillers and serves as a reliable guide in all stratigraphic studies

Fig. 30. Uneven contact of Waupecan sandstone with underlying shales, Mazon River opposite Johnny Run

of the region. In the southwest part of the quadrangle another bed of coal is found from 60 to 80 feet above No. 2. This coal bed outcrops in Mazon River at Tieders Ford in section 36 of Wauponsee Township (T. 33 N., R. 7 E.), and in section 6 of Maine Township, at Sulphur Springs. A coal bed at this horizon also comes to the surface on Waupecan Creek in the SE. ¼ section 20 of Wauponsee Township (T. 33 N., R. 7 E.), where it was worked at an early date, but not much coal was removed. In the latter place it was classed by Bradley[14] as No. 4 seam of the Illinois section, while at Sulphur Springs outcrop it is commonly classed as No. 7 coal by drillers and others. The latter correlation is based on similarity of lithology and stratigraphic sequence of this section with that near Cardiff where a bed about 60 feet above No. 2 has been called No. 7. The fact that there is considerable uncertainty in regard to the validity of the correlation at Cardiff lends doubt to the feasibility of extending it farther west where the relations are still more obscure.

[14]Bradley, Frank H., Geol. Surv. Ill., Vol. IV, p. 194, 1870.

However, if this coal is No. 7, then the Waupecan sandstone belongs within the McLeansboro. The Waupecan sandstone, on the other hand, can be traced along its outcrop northwestward nearly to Marseilles. It has the lithologic character and apparently the position of the Vermilionville sandstone of

A

B

Fig. 31. "Millstone" concretions of Waupecan sandstone
A. In place
B. Dislodged by undercutting in shale

Cady,[15] which he finds overlying an erosion surface within the Carbondale at about the horizon of No. 5 coal. In fact, there seems little doubt but that the Waupecan and the Vermilionville sandstones were contemporaneous.

[15]Cady, G. H., Geology and mineral resources of the Hennepin and La Salle quadrangles: Ill. State Geol. Survey Bull. 37, p. 57, 1919.

The correlation of the Sulphur Springs coal with No. 7 of the Illinois section appears unwarranted and its assignment to a position between No. 2 and No. 5 coals is more in harmony with the data at hand. On this correlation all beds in the Morris area above No. 2 coal belong to the Carbondale. It must be remembered, however, that the coal bed in question is only locally developed and shows marked variation in thickness so that positive correlation can not be made at the present time.

In one boring in section 14 of Braceville of Braceville Township (T. 32 N., R. 8 E.), a thin bed of coal was found about 20 feet above No. 2 coal. This lies between No. 2 and the bed which has been called No. 7. This bed has not been recognized in any other log from the Morris quadrangle, and may fairly be regarded as a northern extension of one of the lower beds of the Cardiff field.

One other formation in this Carbondale section is worthy of more than passing mention. The fossiliferous shales of Mazon River, from the great variety of forms as well as the perfection of their preservation, have become famous among paleontologists and collectors generally.

These beds are exposed prominently in the banks of Mazon River at two localities. The first is along the north-trending part of the stream, in the SE. ¼ section 13 of Wauponsee Township (T. 33 N., R. 7 E.); the second is about two miles upstream just above the sharp bend in the SE. ¼ NW. ¼ section 30, Felix Township (T. 33 N., R. 8 E.).

These beds are shales, mainly without grit, although somewhat sandy in places. They are gray, becoming brown and plastic on weathering. They are finely laminated and in most places cut by many intersecting joint planes. The striking lithologic feature is the presence of great numbers of brown-coated ironstone concretions. These are of varied shape, but invariably have the shortest diameter normal to the bedding planes. Although one or two layers are to be noted, the concretions show almost no regularity of disposition, appearing irregularly throughout the beds. Within the concretions, but not elsewhere in the formation, are the organic remains for which these beds are noted. Without apparent exception the concretions enclose some organic matter, such as a bit of plant or shell, and in some instances a whole leaf is found. Much more rare are the concretions containing a whole insect or fish skeleton. The perseverance of the collectors is indicated by the fact that nearly a score of species of cockroaches have been named from specimens found here. The fossils thus formed show remarkably perfect preservation, so that examination and classification are greatly simplified. The concretions show bedding planes running through them, along which they are usually readily broken. In fact, the failure of an experienced collector to break a concretion cleanly through the middle is commonly taken as indication that the concretion is without a well-preserved fossil.

Pleistocene System

That the reader may have a proper understanding of the references to early Pleistocene history in the following discussion, it is necessary that he bear in mind the complex nature of the glacial history of the region. An examination of the deposits of the United States shows that there have been no less than 13 recognizable stages and sub-stages in the time which is called the Glacial period. For convenience, these subdivisions, numbered in the order of their age, are listed in tabular form:

No. XIII.	The Champlain sub-stage (marine)
No. XII.[a]	The Glacio-lacustrine sub-stage
No. XI.[a]	The Later Wisconsin (the sixth advance)
No. X.	A deglaciation interval (not named)
No. IX.	The Earlier Wisconsin (the fifth advance)
No. VIII.	The Peorian (the fourth interglacial interval)
No. VII.	The Iowan (the fourth invasion)
No. VI.	The Sangamon (the third interglacial interval)
No. V.	The Illinoian (the third invasion)
No. IV.	The Yarmouth (the second interglacial interval)
No. III.	The Kansan (the second invasion)
No. II.	The Aftonian (the first known interglacial interval)
No. I.	The Nebraskan (the earliest known ice invasion)

[a] Represented in Morris Quadrangle.

It should be recognized that these stages represent intervals of time which were by no means equal, the earlier ones being markedly longer than the later ones. Furthermore, because the Wisconsin ice sheet was the last of the ice invasions, it is possible to distinguish the deposits made at different stages of this advance and recession.

PRE-WISCONSIN DRIFT

Although the Morris region must have been covered by the Illinoian and some of the earlier ice-sheets and hence presumably received more or less deposit therefrom, there is scant evidence of any deposit of pre-Wisconsin age now to be found. A suggestion of the presence of such early deposits is found, however, in the occurrence of fragments of tree trunks in borings. Drilling has also shown the rock surface below the drift to be distinctly uneven, as though trenched by stream valleys. While not enough drilling has been done to define the course of these depressions, it is evident that they are rather sharp and steep-sided in many places. Such depressions, especially if trending in a northwest-southeast direction, would have been filled with the debris from the earliest glacier passing over the region and in many instances probably would retain part of this deposit to the present. It is thus clear that although over most of the quadrangle the bed rock lies relatively close to the surface, even there the valleys which antedated the Wisconsin ice-sheet may hold remnants of an earlier glacial deposit.

WISCONSIN DRIFT

Beginning with the oldest, the more important drift deposits of the Wisconsin epoch are known as the Shelbyville, Champaign, Bloomington, Marseilles, Minooka, Valparaiso, and Lake Border drift sheets. The above-named drift deposits comprise those of both the Early and Late Wisconsin ice. Late Wisconsin time, as now classified, began with the advance of either the Marseilles or Minooka ice-sheets, but the evidence for the separation of the Early Wisconsin and Late Wisconsin deposits is not clear.

BLOOMINGTON DEPOSITS

Of the several drift sheets of Wisconsin age, none earlier than the Bloomington is known to be present in the Morris region. In fact, Bloomington till has not been recognized within the quadrangle, although it is found in considerable thickness less than four miles west in the valley of Hog Run in section 29, Norman Township (T. 33 N., R. 6 E.). Where known, the Bloomington till in this region lies beneath the Marseilles drift. If restricted to this position, as seems likely because of the thin drift cover over most of the area, it will be found only in the southwestern part of the Morris quadrangle, perhaps only west of Waupecan Creek. In this area most of the streams have not yet cut deeply enough to disclose any pre-Marseilles drift. Careful search along Bills Run, which has a steep-sided valley 60 feet deep, failed to reveal any drift not evidently of Marseilles age. Bloomington till may be present, but if so, is concealed by slope-wash or vegetation.

Like all such deposits, Bloomington till is gritty, and carries numerous boulders. It is distinguished readily from the overlying gray Marseilles till by its pinkish color, and in almost all exposures it is more compact than the later till. As found in Hog Run, the exposure nearest the Morris area, this till is about 20 feet thick and in the region just west of Waupecan Creek it is presumably somewhat thinner.

Lacustrine clays.—Overlying the Bloomington till is a thin series of sands, gravels, and lacustrine clays of pre-Marseilles age. While neither the lower till nor the gravels is found within the Morris quadrangle, lacustrine clays are found (1) in the valley of the East Fork of Nettle Creek in the NE. ¼ section 4 of Morris Township (T. 33 N., R. 7 E.), (2) along the town-line road at the north line of section 4, and (3) about 300 yards to the north in a creek bank (Pl. II). The elevation of these clays is just under 520 feet above sea level, which is approximately the elevation of the lower part of the ten feet of clays found over sands, gravels, and Bloomington till seven miles to the west, along Carson Creek in the NW. ¼ section 17, Erienna Township (T. 33 N., R. 7 E.). In character the Morris clays are identical with those on Carson Creek and hence they are believed to represent remnants of the same widespread lake deposit.

The clays are finely laminated, and of various colors, brown, chocolate, pink, green, gray, and yellow. The yellow beds are mostly sandy, but the clays on the whole are not gritty. The laminations are slightly uneven in all parts of the deposit and in places are extremely irregular in thickness and extent. This is particularly true of the thin sandy phases which are interbedded with the clays. In no case was a sandy phase found to extend horizontally more than two or three feet, and in most cases less than one.

The greatest exposed thickness of these clays is less than 20 feet. A well at the tile plant at Morris records 34 feet of clay, but since a streak of coaly matter was encountered at about 20 feet and a fragment of well-preserved wood was found, it is possible that the lower 10 or 15 feet of the "clay" may be Bloomington or some older till. The relation of this deposit to the underlying Pennsylvanian strata suggests its history. The excavation of

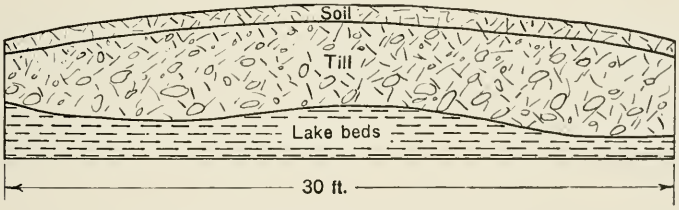

Fig. 32. Section of lake clays beneath till, exposed on south line of sec. 33, Saratoga Township

the clay pit shows the clays to have been deposited in a sharp depression in the sandstone which practically surrounds them. The clays were clearly overridden by the ice of the Marseilles stage, but were protected from removal by the walls of sandstone on all sides.

The outcrop along the town-line road shows clearly the position of these clays beneath Marseilles till (fig. 32), as is indicated by their relations in the clay pit in section 4. Their age, therefore, is post-Bloomington and pre-Marseilles. This determination is at variance with that of Sauer who considered the overlying till to be post-Marseilles in age.[16] Without doubt these clays were laid down in a lake whose surface was more than 530 feet above sea level. Its upper limit is not known from exposures within this quadrangle. The extent of the lake is likewise not known further than that it reached from Morris to Seneca along the site of the Illinois valley.

MARSEILLES DEPOSITS

The next younger deposit is that made during the Marseilles sub-stage. At this time the ice built the prominent ridge which extends in a general north-south direction from Marseilles. The western boundary of the Morris quadrangle coincides approximately with the eastern margin of this

[16]Sauer, C. O., Geography of the Upper Illinois Valley: Ill. State Geol. Survey Bull. 27, 1916.

morainic ridge, which marks the western edge of the depression known as the Morris basin. East of this ridge the ground moraine of the same ice-sheet appears at the surface except where it has been removed or concealed beneath later deposits. Erosion has nearly or quite removed this ground moraine from a belt two to seven miles wide along the present Illinois valley, and where not removed within this belt, it has been covered by later deposits. Minooka Ridge, too, is of younger drift and conceals the older.

The ground moraine of this region is typically blue-gray boulder clay, which is gritty and hard when dry but plastic and sticky when wet. The till is massive and in stream bluffs and road cuts frequently stands in nearly vertical walls. The included boulders are of many kinds. The resistant, well-rounded boulders of crystalline rocks, both igneous and metamorphic, are less abundant than those of limestone which have more or less angular shapes. The sandstone and shale which the glacier must have picked up in passing over the Pennsylvanian terrane were apparently not able to withstand the grinding of glacial operations and were reduced to sand and clay particles which help to make up the matrix of the till. In places the sandy material predominates and not infrequently a cut or boring shows the presence of considerable quantities of an ill-assorted mixture of clay, sand and gravel.

On weathering, the till changes color, the blue giving place to buff and brown. At the same time it loses its content of calcium carbonate, and breaks down to a relatively incoherent mass. Weathering progresses unevenly, the rate being controlled by the topographic position of the till, its porosity, composition, and other related factors. Auger borings show that leaching of the calcium carbonate and other changes of weathering have reached a depth ranging from 20 to 48 inches, averaging about 24 inches for the level till surface. The greater depth to the unleached till in places results from the superposition of a loess-like deposit which may be more than 20 inches thick. This was originally either of leached or readily leached material, and hence is not to be confused with the true till in estimating the depth to which leaching has occurred. In places, a more sandy till shows incomplete leaching to greater depths, more than 120 inches being recorded for a boring on section 19 of Saratoga Township.

The Marseilles drift shows marked variation in thickness. The irregularity of the surface on which it was deposited is a factor in producing the variations in thickness. In general the drift covering is thin in the vicinity of Lisbon, in the Aux Sable valley, and along the Illinois valley, and thicker in the southwestern part of the quadrangle. In the latter area it averages about 60 feet, while at the northwest it feathers out to a veneer of a few inches. Notable variations in this thickness are found which in places suggest the presence of pre-Marseilles depressions of stream origin.

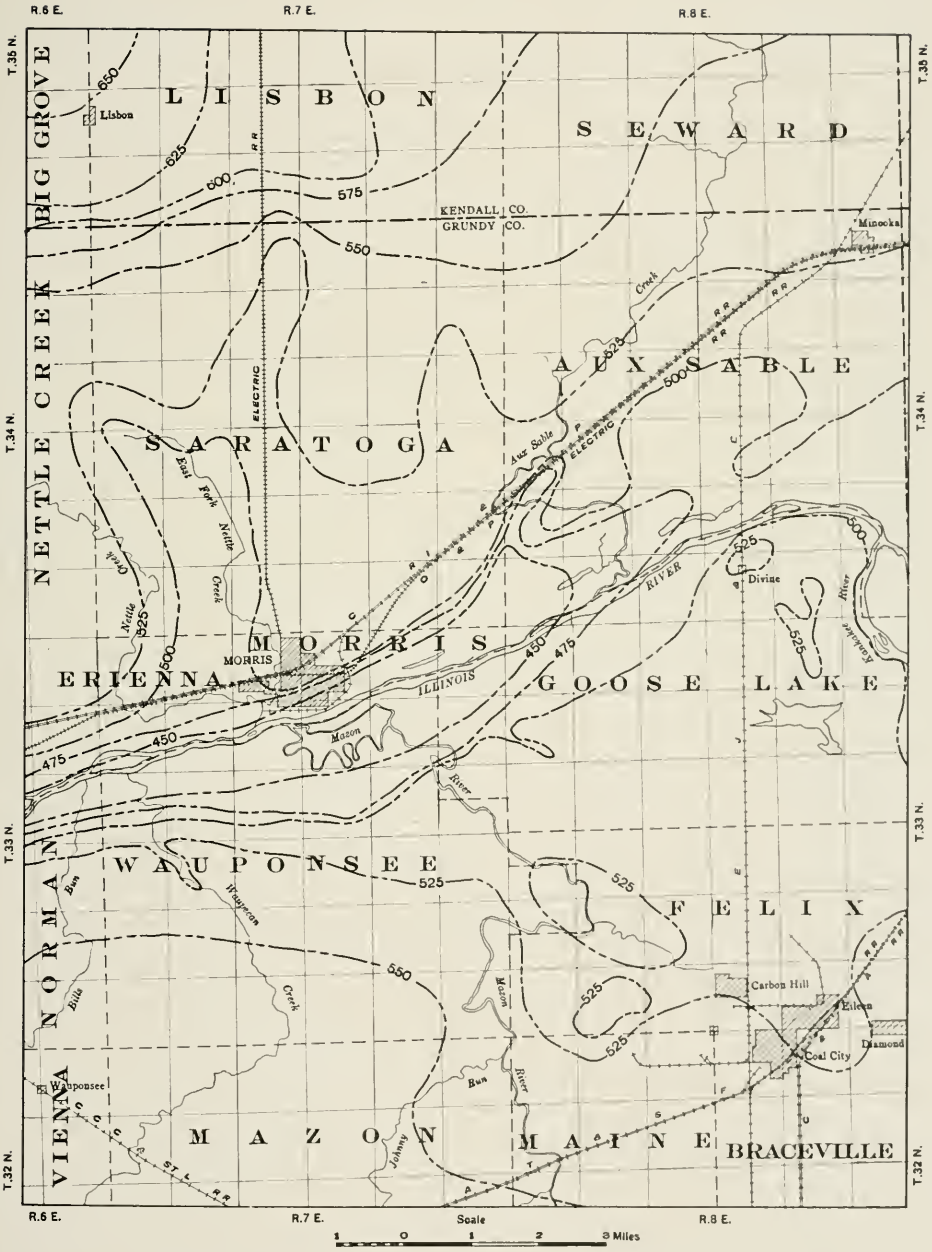

Fig. 33. Map of Morris Quadrangle showing contours on bed rock surface

Although in part developed by post-glacial erosion, the present bed-rock surface, where covered by till, is believed to be essentially the same as that of pre-Marseilles time. On figure 33 are presented contours, based on well records and outcrops, showing the present bed-rock surface.

Topographically, the drift sheet of Marseilles age in this quadrangle has a distinctly subdued expression which apparently is original. Certain knolls and ridges appear, but these are prominent by reason of their rarity and serve to emphasize the monotonous topography of the region as a whole. Among these elevations are to be noted a low, uneven-topped ridge trending northeast across the extreme northwest part of Saratoga Township and the adjacent territory. This is little more than a row of elongated knolls which uniformly show slightly worn and poorly assorted sand and gravel on the northwest side and are apparently correctly interpreted as kame-like deposits made when the edge of the retreating ice stopped at that position for a short time. These lie above the 620-foot level in part, and in part between 600 and 620 feet.

Another ridge, more prominent topographically, is in section 13 of Saratoga Township. This is about 20 feet above the adjacent surface and appears to be a till ridge without sand or gravel on top, although a drill record from its west end shows 41 feet of "surface," probably till, with 15 feet of sand beneath and with 15 feet of hard pan between the sand and the underlying rock surface. That this is not a rock hill with till veneer is evident from the fact that the rock surface here is lower than that of nearby outcrops of Ordovician limestone.

About three miles west of Aux Sable Creek and trending parallel to the course of that stream is a series of low-rounded hills of till. Their distribution and character suggest this as the position of the ice front during another halt in its retreat. They may also be interpreted as the deposit made by ice advancing farther than Minooka Ridge, either before or after it was formed. The northernmost of this series of hills appears in the south half of section 21 of Seward Township (T. 35 N., R. 8 E.), Kendall County, about a mile west of Shurtliffe bridge. A small elevation appears just north of this, but whether it is a part of this series or not is not clear. To the southwest there is a hill in section 29, another in 32, another in 31, of the same township, and a possible continuation is noted in a southwest projection of the higher land across the county line in section 2 of Saratoga Township (T. 34 N., R. 7 E.). These are all marked by the 580-contour line. If the interpretation of this series as a recessional moraine is correct, the ice front maintained a position essentially parallel to the Marseilles moraine during its retreat. This would probably involve the continuance of the projection of ice in the valley of the Illinois, and this, in turn, would be an important factor in the frontal conditions south of the valley. The ice in

the valley would serve as a barrier between the waters north and south of it, and drainage conditions on either side would be unrelated.

MINOOKA DEPOSITS

This deposit, probably post-Marseilles in age, lies mainly east of the area under investigation, but its west margin encroaches on the Morris area. It covers the earlier deposits over the area north of the Illinois and east of Aux Sable Creek. Minooka Ridge, extending from Dresden Heights northward beyond the limits of the quadrangle, and forming the northeastern rim of the Morris basin, is the outer ridge-like border of the Minooka drift. The origin of the ridge, however, is not clearly indicated by its features as within the Morris quadrangle. These include, (1) a slightly curved trend, convex westward; (2) a steep erosion slope at the south and east; (3) a western slope, less steep and not evidently developed by erosion; and (4) a remarkably flat top about two miles wide.

The prominence of the ridge as viewed from the adjacent lowland, although obviously due in part to recent erosion, strongly suggests a terminal moraine. The absence of the usual topographic features of a terminal deposit and the flat top, which apparently is continued in the upland east of the Des Plaines, favor an origin beneath the ice-sheet rather than at its edge. Possibly the available data are best harmonized in the conclusion that Minooka Ridge represents deposition under the edge of the ice readvancing after a recession from the Marseilles moraine and staying at its line of maximum advance only a short time. Inspection of the extension of Minooka Ridge, especially to the north, where outwash deposits have been reported,[17] may yield conclusive evidence on the question.

This till is bluish or greenish gray in color, weathering to the same buff or light-yellow colors assumed by the Marseilles drift. In fact its chief difference from that drift is the relative scarcity of included boulders. No section of more than 20 feet of this deposit has been observed, the steep slopes of the southern extremity of the ridge being so covered with slope wash and vegetation as to make observation there impracticable (fig. 13). Consequently neither the thickness nor the relation of this till to the underlying material has been determined. The few well records at hand show a uniform thickness of about 100 feet for the material above Ordovician limestone at the south end of the ridge and about 20 feet less at the north end. Whether this is largely or only in small part Minooka till is not known.

The relation of the Minooka ice to that of the preceding Marseilles and of later stages is not clearly shown by data available in the Morris region. Because of the short time involved it makes little difference whether the Minooka moraine be considered as a recessional deposit of the waning Marseilles ice, or as a terminal ridge developed during a readvance of the ice.

[17]Leverett, Frank, The Illinois glacial globe, U. S. Geol. Survey Mon. 38, p. 322, 1899.

The flat top of the ridge has suggested the possibility that an earlier ridge, possibly of Marseilles age, and formed as a recessional moraine during the retreat of that glacier, was later overridden by readvancing ice which, however, went only a few miles westward, stopping in the valley of Aux Sable Creek. The extraordinary abundance of boulders in this vicinity has been interpreted as the result of deposition by this later ice.[18] No additional evidence favoring this hypothesis has been secured and its retention appears questionable.

FLUVIAL AND LACUSTRINE DEPOSITS

Overlying the glacial deposits just described are certain stream and lake deposits related to the later glacial history of the region. These are referable to certain stages in the development of the Illinois valley, which is now occupied by a descendant of ice-fed streams of much greater volume and power. Plate II shows the topographic relations of the deposits in the Morris quadrangle and Plate III*A* shows their general relations over the whole Morris Basin.

Of these later deposits the oldest has a maximum elevation of about 560 feet above sea level. This is a barely discernible ridge of sand and fine gravel at the junction of the widespread plain above the 560 level, with the prominent flat some 15 feet lower. Associated with this ridge is the silt covering of the lower flat. The only place in the quadrangle where these relations are clear is at Coal City. Here the slope separating the two flats is well marked and the silt and sand deposits of the lower flat reach a maximum thickness of more than 10 feet, 17 feet being recorded in a boring in section 26, Felix Township. These deposits seem fairly interpreted as those of a rather large lake whose surface was about 560 feet above sea level, and whose waters, coming from the melting ice to the east, were damned at the west by the Marseilles moraine, perhaps near Seneca. Traced southward nearly to Mazon and thence northwestward to the Illinois along the Waupecan valley, the slope joining these two flats becomes inconspicuous, and only in places are the above-described relations suggested. Certain knolls rising above the 560-foot level on the east side of Waupecan Creek in section 28 of Wauponsee Township (T. 33 N., R. 7 E.), suggest by the character of their surface material that they may be remnants of a bar-like deposit related to the deposits in question. North of Illinois River the only traces of any beach deposit at this level are those found on the Nettle Creek road, where a slight accumulation of sand suggests that origin.

Elsewhere within the quadrangle below the 560-foot level silt or sand deposits are suggested in the character of the soil but the original limits of this type of sediment have been altered by slope wash, wind action, and cultivation, so that it is no longer possible to draw the boundaries in detail.

[18]Leverett, Frank, The Illinois glacial globe, U. S. Geol. Survey Mon. 38, p. 327, 1899.

Topographic details will be added in the summary of evidence on the existence of this body of water presented in connection with the glacial history of the region.

In this connection, it is of interest to note that along the eastern margin of the Morris basin, in Will County, there are remnants of a fairly well-developed beach line at the 560-level.[19] There are also prominent gravel and sand deposits showing in places inclined bedding both south of Wilmington and southeast of Channahon. These apparently mark the mouths of heavily laden streams entering this body of water.

Another group of deposits, still younger, is found at about the 540-foot level. Beach development is much more pronounced at this level than at the 560-foot level and is traceable for miles on each side of the Illinois. There

Fig. 34. Dune near east end of Sand Ridge

are no considerable deposits now recognized on the lower flat, however. The beach has its best development north of the Illinois, where there is a relatively steep slope joining the flat, which has an elevation of about 525 feet, with the 550-foot flat to the north. The top of the slope is marked by a low ridge having a maximum width of 50 feet and averaging 2 feet high. The ridge is composed of worn pea gravel in a sandy silt matrix, wholly leached of calcium carbonate. The surface north of the ridge is an essentially level plain rising northward about 5 feet to the mile. The surface south of the ridge is slightly undulating with swamp areas suggesting channel scars. Boulders are abundant on this lower flat, whereas they are nearly absent on the higher.

[19]The beach line may be seen in sections 1, 2, and 12, Wilmington Township, and the sand and gravel with delta bedding appear at the north line of section 16, Channahon Township. Similar gravels are to be found in sections 17 and 35, same township, as well as in sections 7 and 18 of Wesley Township.

North of the Illinois from a point near the west boundary of the quadrangle as shown on Plate II the 540-foot contour line marks the position of this old beach, remnants of which are readily seen on each side of Nettle Creek and which can be traced along the Ridge Road to Aux Sable Creek. East of this creek the beach topography, if existent, has been obscured by

Fig. 35. Gravel pit in N.E.¼ sec. 33, Goose Lake Twp.

the development of dunes. Farther southeast beyond Sand Ridge, however, the older topography is still discernible, and the beach can be followed across the Elgin, Joliet and Eastern right-of-way to the steeper slopes of Minooka Ridge west of Dresden Run. Here subsequent erosion by Illinois River has removed all trace of the shore line.

South of Illinois River remnants of an old beach probably referable to this same body of water are to be seen on both sides of Waupecan Creek. From there eastward the abrupt slope with its crown of gravel and sand may be traced readily as far as Mazon River (Pl. II). Beyond this point all trace of the slope separating the two flats is lost, the surface showing a nearly uniform gradient from below to an elevation above the 540-foot level. The wide expanse of wind-blown sand, having its maximum development in the dune area north of Coal City, known as Sand Ridge (fig. 34), gives a plausible reason for the absence of the beach topography.

East of the quadrangle, in Will County, remnants of this beach line are seen at several points, notably in section 11 of Wilmington Township (T. 33 N., R. 9 E.), so that the combined remnants within the Morris basin enclose fairly completely the area covered by this body of water. Considering the lack of silt deposits on the lower flat and the evidences on its surface, it

Fig. 36. View in sec. 33 Goose Lake Twp. showing the topographic relation between the present Illinois flood-plain on the left and the earlier gravel deposits on the right. The 500 foot contour marks the junction of the two areas

appears questionable whether this body of water of sinuous shape and some 20 miles long by 5 miles wide should be called a lake. All conditions seem satisfied by considering it to have been a wide river of low gradient, yet capable, because of local expansion to great width, of forming a prominent beach line. The anomalous feature of these beach deposits, the apparent evenness of the beach itself, is not satisfactorily explained. In the absence of exact levels at the top of the beach, however, it is obvious that an existing down stream slope in the beach line may not be apparent from the topographic map.

At a still lower level there are found certain deposits which clearly are of later age and different origin from those previously described. These include sands and coarse gravels which are restricted to a comparatively

narrow area on both sides of the Illinois. They lie within a trench, mainly shallow, but locally apparently sharp and deep. In the next higher flat, the junction of the two surfaces is marked in places by a 5- to 15-foot slope. They are only found below an elevation of about 525 feet so that their limit is marked approximately by the 520-foot contour line. That portion below the 500-foot level is in most places covered by deposits of recent time. These beds are quite uniform in character and composition, and are readily assignable to a common origin. While not more than 20 feet is exposed at any point, drilling shows them to range in thickness from two or three feet to possibly as much as 60 feet, thus constituting an important group of beds.

A typical exposure is that found in a gravel pit about a mile east of Devine Station in the NE. ¼ section 33 of Goose Lake Township (fig. 35). The section is:

Pleistocene gravel exposed in sec. 33 of Goose Lake Township

	Thickness *Inches*
Soil, black, sandy, with few pebbles, maximum diameter ½ inch	6
Subsoil, gray black, more sandy, pebbles maximum diameter 1 inch	3
Gravel, dark gray brown, variable thickness, average	6
Sand, yellow brown, the lower part finer, clean, with few pebbles of maximum diameter 1 inch, $CaCO_3$ leached	20
Gravel, cross bedded in part, clean, average diameter of pebbles greater than 1 inch. About 50 per cent limestone, the rest igneous and metamorphic rocks, with some chert	30
Sand, locally pebbly, but mainly clean, cross bedded in part exposed	30

Similar beds of gravel and sand were opened in the old city gravel pits at Morris, just north of the junction of the main forks at Nettle Creek. Such deposits have been opened in section 29 of Aux Sable Township (T. 34 N., R. 8 E.), in section 16 of Wauponsee Township (T. 33 N., R. 7 E.), and in scores of places along the Illinois. In fact, they constitute the only local source of clean sand and gravel for this region. The surface of these deposits is slightly more uneven than that of the 525-foot level, and is usually distinguished by its rolling character with bar-like knolls and ridges of sand and gravel.

Overlying the gravels but clearly antedating the recent alluvial deposits of the main valley is a small patch of marl and peaty muck which appear to belong to the closing stages of this 520-foot river. It seems probable that these fresh water beds belong to deposits made in the greatly expanded river rather than in a marginal pond, but there is nothing to indicate whether the water was a lake or river. In the marl bed, uncovered in Bell's stripping near Morris, the following shells are abundant:[20]

[20]The determination of these shells was kindly made by Frank Collins Baker who offered the following sugges ions as to the environment they indicated: "The body of water must have been of considerable size to have supported so large a fauna, but it need not have been very deep. Most of the forms represented are common in water 5-8 feet deep, and a depth of 10-20 feet is sufficient for all the species."

Mollusca from Pleistocene in Grundy County

Planorbis antrosus Conrad
Planorbis antrosus striatus Baker
Planorbis campanulatus Say
Planorbis deflectus Say
Planorbis altissimus Baker
Planorbis exacuous Say
Amnicola leightoni Baker
Amnicola lustrica Pilsbry Variety (new)
Amnicola walkeri Pilsbry
Valvata tricarinata Say
Valvata tricarinata perconfusa Walker
Valvata tricarinata infracarinata Vanatta
Valvata tricarinata simplex Gould
Valvata tricarinata variety (new)
Galba obrussa decampi Streng
Physa anatina Lea
Physa walkeri Crandall
Pisidium, several undetermined species

The relation of these deposits to the earlier ones, as noted above, is one of deposition within a trench cut in the earlier flat. Their relations to later deposits are less simple. The superposition of alluvium of the present Illinois River upon the gravels is shown in the pit at the ice house just south of the Illinois-Michigan Canal at Morris. Here the usual gravels are overlain by about 3 feet of black alluvium which is clearly continuous southward to the river. In fact, the pit is flooded nearly every year. Similar relations are seen in the vicinity of section 5 of Goose Lake Township (T. 33 N., R. 8 E.), where "islands" of sand and gravel projecting above the level of the floodplain constitute prominent knolls. These are outlined with fair accuracy by the 500-foot contour lines (fig. 36).

Modification of these relations through the agency of the wind appears in section 5 of Goose Lake Township, where dune sand is heaped into an east-west trending ridge more than ten feet above the floodplain of the Illinois. This is an active dune area and in its obliteration of the usual topographic relations of the floodplain and the older gravel flat suggests the mode of concealment of topographic forms at the junction of the earlier developed flats at higher levels.

From the composition, structure, and position of these deposits it is clear that they were made by westward flowing streams of such volume and velocity as to be able to transport considerable loads of relatively coarse sediment. Practically no fine material referable to this stage has been found. Hence these deposits are assigned to an early Illinois River of greater volume, though possibly of lower gradient than the present stream.

Genetically related to the foregoing stages of development of the present Illinois valley there are many deposits, individually of small extent but

rather large in the aggregate, which occupy slightly elevated positions above the floodplains of the various tributaries, past or present, to the main stream. These are now terraces of coarse or fine materials, usually well stratified and similar to the deposits of the main stream (fig. 37). In many instances they can be assigned to one or another of these three stages of Illinois River which preceded the present stage on the basis of their elevation and geographic position. While it has not been considered important to map these

Fig.37. Terrace gravels overlying fresh gray till in bank of Nettle Creek sec. 31, Saratoga Twp. The stratified character of the gravels and sand lenses serves to distinguish them from the massive till below. Note the unevenness of the till surface

terraces so as to show their relations to contemporaneous deposits made in the main valley, it may be well to point out localities in which the various terraces are well exhibited. Nettle Creek, in section 31 of Saratoga Township (T. 34 N., R. 7 E.) and southward in the north part of section 6 of Erienna Township (T. 33 N., R. 7 E.), shows a series of terraces from 3 to 10 feet high which apparently were developed during the down-cutting of this stream as the Illinois was lowered (fig. 38). Aux Sable Creek and its tributaries, Collins and Walley runs, show such terrace remnants interruptedly throughout most of their valleys in Aux Sable Township (T. 34 N., R. 8 E.). Such deposits have furnished gravels along Walley Run in sections 7 and 18 of this township.

South of Illinois River, terraces are found along Mazon River and its tributaries, Claypool Ditch and Johnny Run. Along the Mazon these are especially well developed below Tieders Ford in section 36 of Wauponsee Township (T. 33 N., R. 7 E.). Farther west the same relations hold on the downstream portion of both Waupecan Creek and Bills Run.

As is pointed out in another connection, the trend of the streams themselves is evidence of the sort of adjustment to new levels by which these terraces have been developed.

Recent Deposits

The deposits of Recent age comprise alluvium of present streams and dune sands. The area of the former amounts to 12 or 15 square miles in

Fig. 38. Close-up of gravels shown in fig. 37. The distinction between the till and the overlying gravels is clear, while the stratification of the latter is less apparent than in the preceding view

the floodplains of the Illinois and its tributaries. This is mainly a black, more or less sandy silt having a relatively high content of organic matter. It provides excellent soil and where drained properly produces good crops. It is restricted approximately to the area lying below the 500-foot level along the Illinois, but appears at somewhat greater elevation along the smaller

tributaries. The dune sands have already been mentioned. The more prominent areas are at Sand Ridge in Aux Sable Township (T. 34 N., R. 8 E.) north of Illinois River, and at Sand Ridge south of Goose Lake. The former is less than one square mile in extent while the latter covers more or less of five sections across the north end of Felix Township (T. 33 N., R. 8 E.) and extends nearly a mile farther into Will County.

Southeast of Coal City the sandy character of the surface is noticeable, although there has been but little dune formation. East of the county line, however, the development of dunes is so marked as to dominate the topography and to indicate the origin of the sandy covering of the surface at all levels in the southeast part of the Morris quadrangle.

Mention has already been made of the limited dune development southwest of Devine Station in section 5 of Goose Lake Township (T. 33 N., R. 8 E.). Here the advancing sand has so nearly buried the original fence posts that a second fence has been constructed above the first.

Average samples of the sands from these several dune areas were collected and subjected to a simple mechanical analysis. The chief points observed were, (1) the fineness, angularity, and uniformity of size and composition in the sand from southeast of Coal City; (2) the relative coarseness of the sand from the southern Sand Ridge, and its content of stony matter; (3) the dark color and wide range in size and composition of the sand near Devine; and (4) the well-rounded shapes and content of calcite in the sand from Sand Ridge north of Illinois River.

While detailed analysis of these data is out of place here, the general conclusions are of interest. (1) It is clear from the differences in shape and composition that these sands did not have a common source just prior to their latest deposition. This, together with the fact that the dunes lie at several levels indicates a difference in age. Although conceivably the dunes were contemporaneous, the inference of a difference in age is borne out by the fact that the most active dunes are at the edge of the present floodplain while those at the 540- and 560-foot levels have been subdued in large part by advancing vegetation. (2) Sand from southeast of Coal City, although angular, probably has been carried by water as indicated by the uniformity in size of the grains. These are probably of smaller size than would be rounded in the course of stream transportation. This favors the assumption that these sands were blown from a delta formed by the Kankakee where it entered Lake Morris. The wide expanse of the sand southwest of Wilmington made possible the development of extensive dunes without the introduction of much foreign material. (3) The sand from the contact of the floodplain of Illinois River with the older gravel flat contains a considerable amount of alluvium with organic matter which does not appear in the other sands. The burden of silt with much organic matter now carried by Illinois

River is obviously of recent origin and must have been acquired in post-glacial time. The presence of considerable amounts of this silt in the bordering dunes bears out the inference that these are of late origin.

The sand deposits presumably are not thick. The maximum thickness, as determined by observing the relative elevation of the tops of the dunes and that of adjacent flats, is about 20 feet, but the average is much less, probably less than five feet. If there be included in the dune area that portion surrounding the actual dunes on which surface sand is prominent, the area involved would be several times greater and the average thickness a matter of a few inches.

CHAPTER IV—STRUCTURAL GEOLOGY

The attitude of the rocks of the Morris quadrangle was discussed in part in the chapter on descriptive geology, but in order to bring out the general structural relation the facts are reviewed.

The Morris region is one of nearly flat-lying rocks with few horizon markers. The few outcrops and relative scarcity of well data, in combination with the feature just noted, make accurate determination of structure difficult and detailed determination impracticable, except locally.

The St. Peter sandstone was reached in more than 50 wells plotted on Plate II. Contours drawn on Plate III to show the configuration of the surface of the formation indicate a rather uniform dip to the southeast. That this uniformity is apparent rather than real is suggested by the departure therefrom where more numerous well logs are available, but the general southeast dip of about 28 feet per mile is demonstrated, the altitude of the upper surface of the sandstone ranging from 544 feet above sea level at the northwest to 75 feet below sea level at the southeast.

Comparison of elevations on the upper surface of the Galena-Platteville formation fails to reveal the structure because of the truncation of the beds by erosion. Consequently no difference between the altitude of the St. Peter sandstone and that of the overlying formation can be determined. Whether these beds conform to the Morris-Kankakee anticline noted by Cady[21] is therefore not known. This postulated deformation, however, is merely a broad low arching of the beds, and may prove to be non-existent when more complete data are at hand.

The areal distribution of the Maquoketa formation in the north half of the quadrangle indicates a low east dip which does not exceed and may conform to the dip of the St. Peter sandstone. Well records do not clearly indicate the Maquoketa area in the south half and hence the structure cannot be ascertained.

If the Maquoketa is present in the southeastern part of the quadrangle, as suggested by the interpretation of logs quoted earlier (p. 34), the formation may be assumed to be conformable to the postulated Morris-Kankakee anticline.

The structure of the Pennsylvanian beds as a whole seems to be independent of the low arching just noted. On the basis of the structure of No. 2 coal, the base of the Carbondale formation, the Pennsylvanian beds dip southwest at a low angle and this general attitude is interrupted by a

[21]Cady, G. H., The Structure of the La Salle anticline: Ill. State Geol. Survey Bull. 36, p. 133, 1920.

southwest-pitching syncline or basin with very low slopes west of Coal City, and a parallel broad down-warp in the vicinity of Bills Run.

It thus becomes evident that the rocks of this region have suffered more than one deformative movement. The first here recorded occurred in the interval between the deposition of the St. Peter and the Pottsville beds. This may have been merely a tilting of the surface toward the southeast.

The folding along the Morris-Kankakee anticline, if any occurred, may have taken place in pre-Pennsylvanian time since the later beds do not appear to be involved.

A still later movement followed the deposition of the Pennsylvanian beds of this area. This resulted in the general southeast dip shown by this series. The cross-warping which developed the shallow synclinal troughs of Morris (No. 2) coal may have occurred at the same time or later.

It is evident from their areal pattern as well as their proximity to the line of maximum deformation, that all the rocks of this quadrangle were involved in the series of movements resulting in the La Salle anticline. It is possible, however, that the postulated Coal City arch has been of equal importance in determining local structures. The time and structural relations of these two units is beyond the scope of this report, and it suffices to point out that the movements in this area conceivably were contemporaneous with those listed by Cady for the development of the La Salle fold.[22]

Although the Eastern Interior Coal Basin is a stratigraphic or physiographic rather than structural feature, it is well to note its relation to the Morris beds. As has been pointed out, the general coal basin of which this area is a part comprises most of the State of Illinois as well as parts of the states adjoining on the east, south, and west. The deeper portion of the basin lies in the southern part of Illinois. The old surface of deposition slopes toward this deeper part from all sides. In the Morris area this slope probably was of different angles at various times, through deformative movements, but was probably at no time far from flat. The uniform thickness and character of No. 2 coal for example, indicates essentially uniform conditions for deposition over the entire area where that bed now exists. It is clear, also, that the original margin of the depositional basin was north of the present edge of Pennsylvanian beds. It is not apparent, therefore, that the present attitude of the Pennsylvanian strata is due in any degree to the proximity of the area under investigation to the margin of the basin of deposition.

Minor folding of the pre-Pennsylvanian beds has been noted in the description of those strata. Except where revealed by the limited outcrops the details of these minor and more or less localized structures cannot be ascertained. It is obviously probable, however, that such structures do occur

[22]Cady, G. H., Structure of the La Salle anticline: Ill. State Geol. Survey Bull. 36, p. 175, 1920.

and have their effect in the minor intricacies of the areal patterns and in the disposition of the later deposits as well.

The minor structures affecting the Pennsylvanian strata are of much the same order of magnitude as those noted for the pre-Pennsylvanian rocks. Because of the more extensive outcrops and the development of the coal properties, however, the details are somewhat better known. These structures include some minor faulting as well as folding. In the upper beds of this system as exposed along Mazon River, the usually low and distinctly local warping is so common as to constitute the rule rather than the exception. Such deviation from a flat-lying position as that in the center of section 25 of Wauponsee Township (T. 33 N., R. 7 E.) is typical. Another example may be seen just below the sharp bend in SE. ¼ section 19 of Felix Township (T. 33 N., R. 8 E.), where a monoclinal flexure giving 10° dips affects the beds for a few yards. Similar structures are commonly met in coal-mining operations in this region. Cady[23] has introduced rather detailed descriptions of some of these structures, of which the most important is probably that encountered in the Coal City area where No. 2 coal occupies a trough about 1,000 feet wide and 50 feet deep, trending north-south.

Faulting does not appear to be commonly of more than a foot or two displacement, and no extensive faults have been discovered. Such movements of this type as have occurred are probably referable to local differences in contraction and compression of sediments during solidification rather than to regional stresses. Small dislocations are frequently noted underground, and on the surface where the rocks have an essentially vertical exposure they commonly show similar fractures. Such a one appears just below the bridge at Pine Bluff. Here the vertical component of the movement is measured in inches.

[23]Cady, G. H., Coal Resources of District 1 (Longwall): Ill. Coal Mining Investigations Bull. 10, 1915

CHAPTER V—HISTORICAL GEOLOGY

The foregoing presentation of data concerning the character, disposition, and stratigraphic relations of the various formations of the area is the basis for inferences regarding the depositional and erosional conditions in times past which in turn lead to certain conclusions as to the sequence of events in this region. The province of this chapter is the delineation of these events so as to bring out their interrelations.

Of the time earlier than the Paleozoic there is no available record. The geographic position of the Morris quadrangle makes it probable that in pre-Cambrian time this region was subjected to erosion which reduced the land to an essentially plane surface. No drilling records are at hand showing the character of the material composing this surface, but by comparison with the area in Wisconsin, where this old surface is exposed, it becomes clear that below the sediments of Cambrian age lies an unknown thickness of crystalline rocks, probably in part igneous but largely metamorphic. These constitute a lithologically complex foundation for all later sediments. At the opening of the Cambrian period, then, this region was perhaps a low-lying land mass, with little relief or roughness.

The Cambrian Period

During the first part of the Cambrian period, with which the Paleozoic era began, the condition of the preceding period probably obtained, since there is no evidence in the surrounding area indicative of an early encroachment by the sea. Later in the Cambrian, however, the relative sinking of the land brought it beneath the sea which encroached from the south, and there was deposited a considerable thickness of sandstones and some shales and limestones collectively known to drillers as the "Potsdam sandstone" and here designated "Croixan." Seven hundred feet of deposits of this period are reported in the Hoge log which was given in full in an earlier chapter (p. 15). Records elsewhere show a maximum of about 1,000 feet deposited in this period.

The Ordovician Period

At the close of the Cambrian period, as appears from evidence reported from outside the quadrangle, the area had emerged from the sea, and undergone extensive erosion. But early in the Ordovician period readvance of the sea made possible further deposition, and the very considerable thickness of sandstones, limestones, and shale followed with relatively slight interruption. It is clear from the varied character of these beds that the conditions obtain-

ing were not as uniform during the Ordovician period as during the Cambrian. The Oneota dolomite was followed by the New Richmond sandstone. A return to earlier conditions preceded the deposition of the Shakopee dolomite. From the larger amount of clastic material of Shakopee age east and north of this quadrangle it may be inferred that the land mass which furnished the sediments lay in that direction with the open sea to the south and west.

Evidence from nearby areas indicates that there was a return to land conditions for a time after the deposition of the Shakopee dolomite. This resulted in the development of an uneven erosion surface upon which, during the succeeding submergence, the St. Peter sandstone was deposited. The details of the conditions obtaining are not determined from data gathered in the Morris quadrangle, yet it is evident that the deposition of this widespread blanket of nearly snow-white sand could only take place under unusual conditions. These have been postulated variously by different authors, but it seems probable that the St. Peter sandstone is mainly water-laid rather than eolian sediment although laid down so near shore as to have received much wind-borne sand.

A period of erosion following the deposition of the St. Peter sandstone is suggested by the apparent irregularity of the upper surface of the formation. This is in harmony with the unconformity at the top of this formation at its outcrops in La Salle County. At some time after the deposition of the St. Peter sandstone there appears to have been a slight deformative movement which resulted in a tilting of the surface toward the southeast. The deep burial of the beds prevents demonstration of this movement. The later transgression by the sea brought about conditions favorable for further deposition, and on top of this uneven surface of St. Peter sandstone was laid the Platteville limestone. With but an inconspicuous break in deposition, if any occurred, the Galena formation followed, a massive dolomite several hundred feet thick.

Following the deposition of the Galena dolomite a change in conditions permitted a thinner series of muds to be laid down. These were in part calcareous, and hardened into the shale member of the Maquoketa formation. This change may have involved a recession of the sea or may have been occasioned by shifting in land drainage. The apparently clean-cut break from the dolomite to the shale is in harmony with a land emergence, which may have been slight and brief. Mud deposition continued until enough to produce some 60 or 70 feet of shale had been laid down, and then the introduction of calcareous material began. This resulted in a series of shales with the interbedded lenses of impure limestone, followed by some 50 feet of limestone. The purity of this upper calcareous deposit indicates clear water conditions in contrast with the muddy waters of early Maquoketa time.

The proximity of this area to the shore line of the Maquoketa sea is suggested both by the change in depositional conditions and by the variation in shale and lime proportions shown by logs from this and adjoining areas. The greater thickness of limestones and shales to the east in Will County suggests that the sea came in from that direction. There is nothing to indicate, however, that the shore line was within the Morris quadrangle.

The record of deformation during the later Ordovician is scanty. It seems plausible that the several changes in position of the shore line were accompanied by more or less uneven uplift or depression of the area involved.

The postulated uplift along the Coal City axis, involving all pre-Pennsylvanian beds, is the only other important event suggested by the evidence at hand.

The absence of any sediments belonging to the periods between the Ordovician and the Pennsylvanian, leaves the history of this interval somewhat in doubt, yet suggestive relations of rocks to the east may be noted in this connection.

East of the Morris quadrangle the Maquoketa formation is overlain unconformably by Silurian beds of either Alexandrian or Niagaran age. It is apparent that the Alexandrian sea may have covered part or all of the Morris area, and its deposit later been eroded. While no trace of Niagaran beds appears in the Morris region, their presence west of the La Salle fold as well as in the eastern part of the State makes plausible the assumption of transgression by the sea at that time. Except for the complete absence of all deposits later than Maquoketa there is no record of events of post-Ordovician and pre-Pennsylvanian time. We know only that erosion prevailed. From evidence in other parts of northern Illinois, it seems probable that the sea covered the Morris region at least twice during the Silurian and Devonian periods.

The Pennsylvanian Period

With the opening of this period began the last widespread deposition by water in the part of Illinois which includes the area under investigation. Because of the character of the deposits made during this period it is the most important from an economic standpoint. During early Pottsville time, while deposits were being made in the deeper parts of the Eastern Interior Basin, the Morris region continued to be subject to the processes of weathering and erosion. Somewhat later, however, the northward extension of the area of deposition resulted in the formation of a series of sandstones, shales, clays, and thin coals. These reveal shallow water and shore conditions with subordinate marshes supporting abundant vegetation. These latter were of limited areal extent and short lived so that no notable accumulation of peaty matter resulted.

At the time of the deposition of No. 2 coal, a more widespread uniformity of conditions was inaugurated. No. 2 coal itself, while showing some variation in thickness, is essentially uniform throughout not only the Morris quadrangle, but throughout an area which possibly includes much of the Illinois coal field. A distinct change in conditions is thus demonstrated, for the extent of any of the Pottsville sediments is markedly restricted. The marsh conditions, under which No. 2 coal was deposited, were followed by conditions permitting the introduction of mud and sand. In these sediments the cross bedding, lenticular character, and horizontal as well as vertical variation in composition suggests constantly changing conditions. This feature, considered in connection with the aggregation of argillaceous and arenaceous material of varied types implies a continental rather than marine area of deposition.

That the deposition did not continue uninterruptedly is shown by the marked breaks amounting to local unconformities noted in another connection. How widespread these were cannot be determined from present data, which, however, do indicate that considerable portions of the quadrangle at least were involved. The differences in contemporaneous sediments in different parts of the area are indicated by the apparent restriction of the well-known Mazon fossil beds to a small area. While more complete data may show a widespread stratum of this type, the two "fossil beds" exposed were apparently deposited in a limited basin. The lateral gradation from argillaceous to distinctly arenaceous types of material appears clear, and indicates a more or less secluded or sheltered area of deposition of the fine muds comprising the fossiliferous shales. The fossil content of the latter proves their non-marine origin.

For a considerable period after the deposition of No. 2 coal, land conditions obtained as shown by the irregular alternations of sandstone, shaly sandstone, sandy shale, and calcareous clastic beds with thin and locally developed beds of carbonaceous material. In places the last named are true coals, but in few places are they thick enough to attract local prospectors.

Toward the close of the Carbondale epoch, coal-forming conditions existed somewhat generally, and a thin bed, possibly to be correlated as No. 5 coal, was laid down over at least the southwestern quarter of the quadrangle. To what extent this bed originally covered the rest of the quadrangle is not known, but well records indicate that subsequent erosion removed all trace of such beds, if they were ever present, over most of Felix and Goose Lake townships. The data are insufficient to warrant inference on this point from generalizations as to thickness or relation to No. 2 coal.

Whether deposition ceased before the close of Carbondale time, or extended into the McLeansboro can be determined only upon the identification of sediments of the latter age. Present data show an absence of either

the limestone marking the basal portion of the McLeansboro beds, or of coals which can certainly be identified as No. 6 or No. 7. The facts at hand can be harmonized easily with the conception of a cessation of sedimentation soon after the deposition of No. 5 coal—the thin upper bed of the Morris area being provisionally so classed—and the subjection of the entire area to weathering and erosion during the remaining pre-glacial time.

The Mesozoic and Cenozoic Eras

Events of Mesozoic and Cenozoic eras apparently did not involve deposition here except during Quaternary time. The drift covering of the area is thick, and the scattered well records do not reveal the pre-glacial topography in sufficient detail to make delineation of erosional changes possible. It is nevertheless clear that just prior to the advent of the ice the relief of the surface was moderate, with the possible exception of the area adjoining the present Illinois Valley. (See fig. 33.) Here the greater relief of the bed rock surface may have resulted from erosion in Pleistocene time, and hence not indicate extensive pre-glacial trenching. From the apparent development of short tributary valleys cut in bed rock, it may be inferred that a late Tertiary uplift had rejuvenated the streams working over an area peneplaned in post-Paleozoic time.

THE PLEISTOCENE PERIOD

The early events of the Pleistocene period have been worked out from data gathered from many parts of the North American continent. This history shows that during this time there were at least five distinct ice invasions, separated by very long interglacial stages. Beginning with the oldest, the glacial stages have been called the Nebraskan, the Kansan, the Illinoian, the Iowan, and the Wisconsin (p. 57). There is no positive record of the Nebraskan or of the Kansan invasions in this part of Illinois, although certain deposits of old till found in Bureau County have been referred to a pre-Illinoian stage by Cady,[24] who also has recognized Illinoian till in the same region. While no deposits clearly of Illinoian age have been found in the Morris quadrangle, its geographic position with reference to the area known to have been glaciated at that time is such that there is no doubt that the Illinoian ice-sheet covered this area.

There is no evidence indicating that ice covered the Morris region during the succeeding Iowan invasion, but there is abundant evidence that the region was almost continually beneath the ice until after the Marseilles stage of the Wisconsin epoch.

During the Wisconsin epoch it is believed that the ice front oscillated repeatedly, but that at times it was essentially stationary long enough to

[24]Cady, G. H., Geology and mineral resources of the Hennepin and La Salle quadrangles: Ill. State Geol. Survey Bull. 37, p. 70, 1919.

permit the accumulation of great belts of till and associated deposits at and under its edge. These ridges, or terminal moraines, dominate the topography in many parts of the State, and include the ridges known as the Shelbyville, Bloomington, Marseilles, Minooka, Valparaiso and Lake Border moraines, respectively.

The history of only the latter part of the Pleistocene period is recorded within the Morris area. It is clear that the region was overwhelmed by continental ice sheets earlier than the local depositional record suggests. It was probably covered by deposits of glacial origin during the Illinoian invasion as well as during the early advances of the Wisconsin ice, but if so, most of the deposited material, and presumably some of the bed rock as well, was removed during the succeeding interglacial stage or the following ice invasion. The presence of glacial striæ on the bed rock surface trending about S. 50° W. (Pl. III) indicates erosion by ice in pre-Marseilles time since the trend of the terminal ridge of that time indicates westward-moving ice. So few such surfaces are observable, however, that the reference of the striæ to a certain invasion is not feasible.

The till and associated deposits comprising the surface of this area were spread out during the latter part of the Wisconsin epoch. It is probable that the ice which formed the Bloomington moraine and is known to have made deposits of considerable extent and thickness in the area west of the Morris quadrangle also left more or less debris in the latter region. After the recession of the ice of the Bloomington stage, a lake was formed over the area between Morris and Seneca. In this lake were deposited the laminated clays found at various points between these places and utilized for tile manufacture at Morris. The altitude of the clays shows that the level of this lake was above 530 feet. The beds may be referable to a 600-foot lake postulated by Leighton on evidence noted farther down the valley, but the identity of these two lakes is not demonstrated.[25] The areal extent of this lake is problematical. To the west, no limit can be set from data gathered within this quadrangle. To the east, the Morris basin must have been inundated as far as the recession of the Bloomington ice permitted until a large part of the quadrangle was under water. The lake boundary at the south, east or north may have been considerably outside the limits of the Morris area,[26] while on the west the Bloomington morainic ridge limited the spreading waters.

THE MARSEILLES STAGE

The advent of the Marseilles ice must have eliminated the eastern portion of the lake east of the Marseilles morainic ridge, which apparently

[25]Unpublished notes.

[26]Recent work by Mr. D. J. Fisher, of the Illinois State Geological Survey has shown the presence of lake sands and laminated clays referable to this lake in the Des Plaines valley.

marks the western limit of the next ice advance and forms the west boundary of the Morris Basin. At the time of the formation of this moraine the ice front stood at the position of this elevated area and the waters from the ice found their way westward presumably down the Fox and Illinois valleys. During this period Morris Basin probably was somewhat aggraded by the ice, as there would be little erosive action so near the ice front.

With the retreat of the ice front to a position slightly behind the crest of the Marseilles moraine there must have been developed a series of ponds between the moraine and the ice. These would fill until an outlet was found, through which the overflow would escape in a series of separate streams. With continued ice recession the ponds would develop into proglacial lakes dammed by the moraine on the west and the ice on the east.

The early water level of these lakes probably was more than 700 feet above the sea, but it is unlikely that this level was long maintained. Erosion at the outlets lowered the water level and slightly reduced the area submerged. On the other hand the recession of the ice eastward would have uncovered relatively flat land and may have greatly increased the area flooded. By the time the ice front had reached the west side of the Morris quadrangle the outlet across the morainic dam probably had been cut down to about 600 feet.

There is little evidence to show that the ice front did not retreat at a regular rate across the Morris Basin. Had it remained stationary for any considerable period of time a deposit similar in character to the Marseilles moraine would have been formed, and its size would have been related to the time involved. Such deposit is found near the west limit of the quadrangle, where a line of low ridges, locally little more than knolls, trends northeastward across the middle of Nettle Creek Township (T. 34 N., R. 6 E.), continuing as far as Central.

There is no evidence to indicate that after this halt the ice did not gradually retreat to the east, at least as far as the vicinity of Minooka ridge.

While the events previously noted were taking place, similar conditions obtained south of the river. The lesser height of the main morainic ridge to the west precluded the presence of any ponds above the 700-foot level, and indeed the area in which a lake of even that level could have been maintained is small. Below that level, as at 680 and 660 feet, there are wide flats, but the absence of higher limiting areas makes problematical the presence of any lakes in this region comparable in size or level with those to the north.

It is probable that during its recession the ice front would show progressively a more regular outline in its larger features while possibly

minor irregularities would be increased. Thus the projection of the ice occupying the site of the present Illinois valley would be eliminated gradually, the front developing a rounded outline only roughly parallel to the Marseilles moraine. By the time the ice had retreated as far as Seneca it is probable that the waters from north and south were uniting to form the early Illinois River. At this time the level of the outlet may have been held by the morainic dam above 600 feet, perhaps as high as 640, and in that case a wide river, shallow and of low gradient may be postulated. This water may have been a lake rather than a river, but a long sinuous shape seems necessarily to have resulted from the topography of the area. The precise boundary of this body of water is not here defined.

With the further retreat of the ice there was exposed a much larger area which would have been covered by the 640-foot water. Whether it was covered or not depended largely upon the relation between the rate of retreat of the ice front and that of the downcutting at the outlet. After the union of waters north and south of the river, the erosion of the single valley across the moraine must have proceeded with relative rapidity. No evidence has been found indicative of the area covered by the 640-foot water, nor indeed at any level above 600 feet. Hence present data lead to the conclusion that the outlet across the Marseilles moraine, if at any time higher than the pre-Marseilles level, 600 feet, was reduced to that level shortly after the withdrawal of the ice of the Marseilles stage.

That a body of water existed at the latter level, in post-Marseilles time, is indicated by the presence of a gravel and sand deposit in the southeast quarter of section 8, Erienna Township (T. 33 N., R. 7 E.), south of Long Point school (Pl. III*A*). A similar deposit was observed by Leighton about a mile to the northwest. These consist of well-assorted gravels and sands exhibiting delta bedding. The upper surfaces lie between 600 and 620 feet above sea level and may be interpreted as deposits made at the mouths of streams entering a lake at that level.

The fact that a lake at approximately this level was in existence prior to the advent of the Marseilles ice, as noted above (p. 84), leads to the inference that after the dam of morainic material at Marseilles had been eroded to the 600-foot level, the same obstacle to further erosion of this valley which had been operative in pre-Marseilles time, again became the controlling factor with the result that a lake was again maintained at that level.

The duration of this lake through any considerable period would have resulted in the production of the usual depositional and erosional shore features of such bodies of water. The absence of these features is good negative evidence of the relatively early lowering of the lake level. However, the drainage pattern of Nettle Creek suggests that the upstream part

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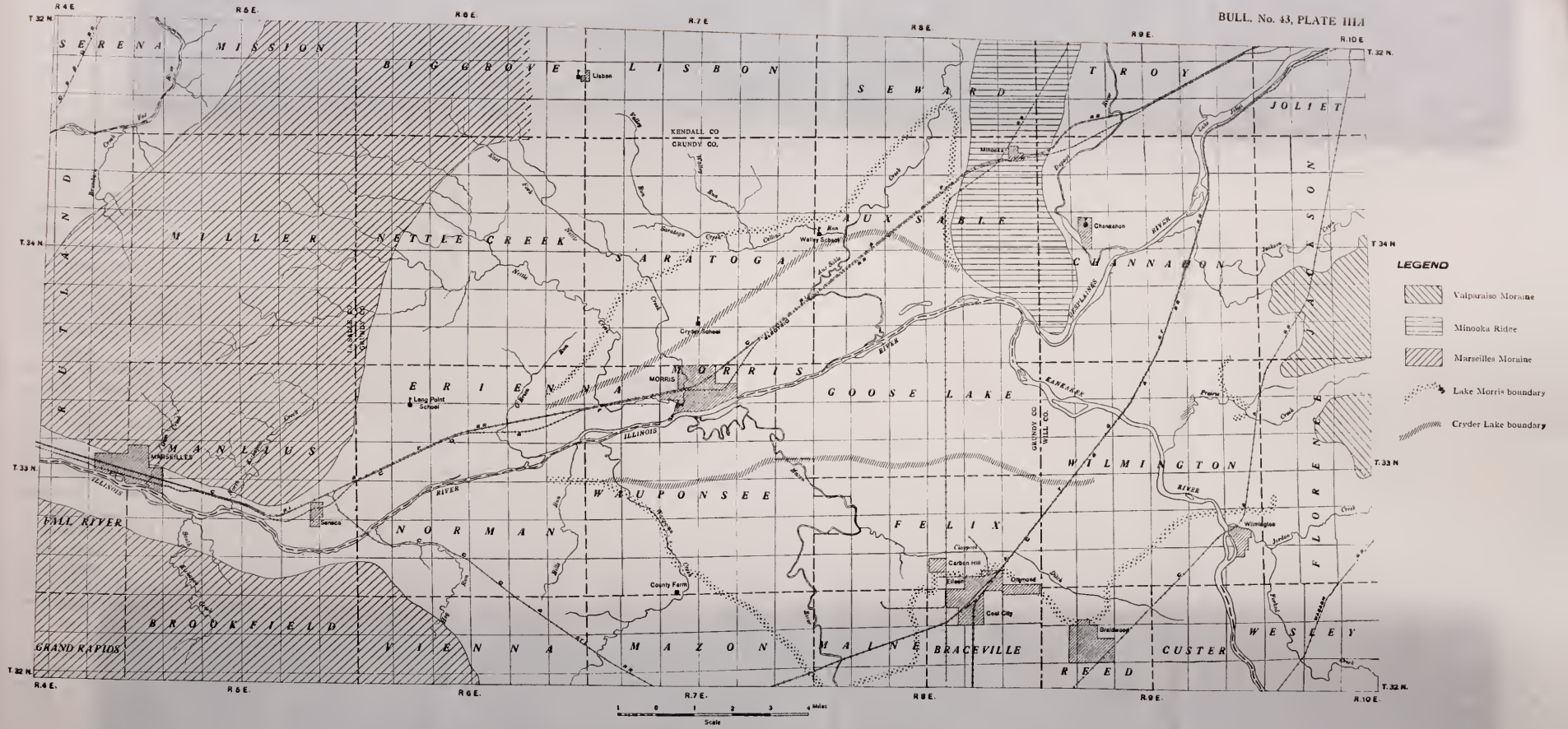


Map of Morris Basin showing major physiographic features

antedates the downstream part. There is a much better development of tributary valleys and ravines above than below the 600-foot level.[27] This is the normal relation if the mouth of the stream was lowered after having been at the 600-foot level for some time, and substantiates the assumption of a 600-foot lake.

There is nothing in the topography of the region to indicate that after the lowering of this 600-foot lake there was not a regular withdrawal of the ice to the east, and a nearly equally regular lowering of the level of the water by erosion of the outlet channel.

The shape of the ice-front during the recession of the ice sheet was at all times an important factor in the disposition of the lines of drainage, ponds and associated deposits. The position of the ice during the early stages of its retreat can be read from the topography today, but later erosion of the valleys of the Illinois, Des Plaines and Kankakee rivers has removed a large part of the glacial deposits east of Morris, and consequently the exact outline of the ice-front at any given time is problematical. For example, no evidence has been secured which indicates the position of the ice-front—which was probably the eastern limit of the water—at the time the 600-foot lake existed.

Between that stage and the time of removal of the ice from the south half of the quadrangle, there is no trace of the succeeding positions of the front. North of the river there is a suggestion in the elongate ridges along Aux Sable Creek that the ice was stationary for a time along that line. Sand and gravel appear in the N. E. ¼ of section 9, Aux Sable Township (T. 34 N., R. 8 E.), where they lie on the west slope of a ridge and were apparently deposited at the edge of the ice. Whether this occurred during the retreat of the Marseilles ice or at the time of the formation of Minooka Ridge is not determined.

From the valley of Aux Sable Creek eastward, all trace of the deposits of the Marseilles ice is obliterated by the younger Minooka till. The extent of the retreat of the Marseilles ice prior to the formation of this deposit is not known. It seems probable that land as far east as Joliet was uncovered, although the recession of the ice east of the head of the Illinois is not demonstrated.

THE MINOOKA STAGE

Apparently the next important event, following the recession of the Marseilles ice across the Morris Basin, was the formation of Minooka Ridge, which, rising prominently above the basin, marks its northeastern margin. The time elapsing between these two events can be determined in the broadest terms only. As compared with the other interglacial stages

[27]The upstream portion is shown on the map of the Marseilles Quadrangle.

of Wisconsin time, it probably was of short duration. As pointing to this conclusion, there is no indication of the development of an interglacial soil. Indeed, the distinction between the two tills is by no means clear in some places.

Throughout the Minooka stage there was maintained in the Morris Basin the lake which was formed after the recession of the Marseilles ice. When the Minooka ice began its retreat there ensued a series of events of the same general type as those noted for the Marseilles stage. At first, waters flowed across Minooka Ridge in sec. 13, T. 36 N., R 8. E., as noted by Leverett.[28] These waters must have followed the Aux Sable Valley to the edge of the lake occupying the Morris Basin. To what extent the waters from the receding Minooka ice overflowed to the southwest and south can not be told from present topography since all trace of any such drainage, if it existed, has been removed by subsequent erosion. With the details of this retreat and of the events during the succeeding Valparaiso stage of the ice in the region northeast of Joliet the present report is concerned only in so far as these events determined processes and results down the valley to the west.

The Lake Morris sub-stage. At some time after the withdrawal of the Marseilles ice and probably before the formation of the Valparaiso moraine the level of the lake in Morris Basin was lowered from 600 to 560 feet. As already stated, it seems probable that this lowering took place soon after the withdrawal of the Marseilles ice. The absence of outwash from the Minooka till ridge in the nature of delta deposits referable to the 600-foot stage substantiates this view. As in the case of the 600-foot lake, the site of the obstruction for the 560-foot water lies west of the Morris quadrangle. It is clear that the downcutting of the outlet would progress rapidly until bed rock beneath the till was reached. The presence of Pennsylvanian strata in the valley walls near Marseilles up to about 560 feet[29] may have been the cause of the maintenance of a lake at that level in the Morris Basin. Any extension of the lake west of the site of Morris must have been little more than a widened river, since the 560-foot contour lines converge sharply there.

Suggestion that the water level was maintained at about 560 feet for a much longer time than at any higher level in the Morris Basin is found in the more abundant evidence of its existence at that level. Not only does the drainage pattern of Morris Basin suggest such a lake but there are numerous deposits which by their character, disposition and elevation practically fix the limits of this body of water (Pl. III*A*). For convenience of discussion, this lake of post-Marseilles age, which filled the Morris Basin

[28]Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 319, 1899.
[29]Cady, G. H., Field notes on Ottawa-Marseilles quadrangles.

up to about the 560-foot level, covering an area of some 150 square miles, is named *Lake Morris.*

North of the Illinois the evidence of this lake is meager. Isolated, inconspicuous sandy patches, such as that transverse to Nettle Creek in section 20 of Saratoga Township (T. 34 N., R. 7 E.), suggest a beach, but the exact area occupied by the water at this level is problematical. There is little reason to believe that the topography has been subsequently modified to a greater degree here than on the south, or that the surface has been deformed, and it is assumed that the 560-foot contour line marks the approximate extent of the lake waters.

The Aux Sable Valley must have been in large part covered by waters of Lake Morris. Although the topography of the valley suggests some aggrading prior to the recent erosion by the Aux Sable, it is not evident that any vigorous erosion was taking place on the west slope of Minooka Ridge.

In case the valley of the Aux Sable was inundated, the low till ridges and hills north of Sand Ridge were islands. Their topography is fresh, morainic, and little modified by stream action. Any shore features that may have been developed along the southern margin of Minooka Ridge have been obliterated by subsequent erosion.

The lack of a beach on the north side of the lake, contrasted with the marked beach ridge on the southeast, points to certain controlling conditions. Accumulations of beach material could be derived only by the reworking of a large amount of till. Such sorting is normally performed by rivers traversing the area or by waves and undertow at the beach. On the north, only a limited area was drained by tributaries to Lake Morris, and this region was smooth and of slight relief. In the short time between the retreat of the Marseilles ice and the lowering of the lake level no systematic drainage developed, and hence the region could not have been subjected to vigorous stream action. Under these conditions little material was brought to the shore for the building of a beach. Furthermore, in view of the long gentle slope of the lake bottom, the short life of the lake itself precluded the chance of enough shoreward cutting to supply material to make a beach comparable with that found elsewhere. To the south and east, however, conditions were radically different and were favorable to the development of beaches of distinctive size. From the southeast along the margin of the ice came the flooded Kankakee, overloaded with debris from the glacier.

This stream brought great quantities of fine gravel, sand and silt to the lake and from them the prominent beach could be formed. Under these conditions, a silt filling of some consequence might be expected in this region, and evidence of such deposition is found in auger borings on the pronounced flat north of Coal City and west of Wilmington. Kankakee River at this

time was aggrading its channel, and by the close of the stage of the 560-foot lake, probably had filled the valley in the vicinity of Ritchey to the 560-foot level, possibly as high as 570 feet, as indicated by the gravel deposits remaining there. The valley here is about two miles wide, so that a considerable filling is suggested.

Downstream, to the north, the finer gravel and sand were deposited in great quantity and were spread over a wider area by the stream, which, on reaching the gentler slopes of the lake shore, was heavily overloaded. The absence of shore features across the sand flat may be ascribed to the continued introduction of sand during and even later than the life of the lake.

Conditions on the east side of Lake Morris were essentially the same as along the southeast shore. On both sides of Prairie Creek, section 12, Wilmington Township (T. 33 N., R. 9 E.), Will County, are low ridges of sand and gravel, suggestive of beaches.

A similar deposit lies along Grant Creek, north of which a thick gravel deposit slightly above the 560-foot level shows clearly the entrance to the lake of a heavily laden stream from the north. Northwest of this deposit, east of Channahon, similar deposits indicate valley filling entirely across the gap between Minooka Ridge and the similar till surface more than four miles to the east.

In its early stages, the valley-filling of the Des Plaines was in the nature of valley-train deposition, including slightly inclined beds, with current bedding prominent. With further retreat of the ice the development of a lower gradient resulted.

That the above noted heavy gravel deposits of the Des Plaines Valley are outwash from the Valparaiso glacier was shown by Leverett,[30] who further suggested that the abrupt termination of the gravels near Channahon was due to the presence of a lake in the Morris Basin.

Just as the history of the Morris Basin thus far outlined is closely tied to events in the glacial history of the area immediately to the northeast, so in the later stages of its history the controlling conditions are found to be in the Lake Michigan Basin.

Following the Valparaiso stage of glaciation came the Lake Border stage, when the ice extended little farther than the Lake Michigan depression. Its waters, however, continued to flow down the Des Plaines and Illinois valleys.

The Cryder Lake sub-stage.—The downcutting at the outlet must have continued during the Lake Morris sub-stage, but when the 540-foot level was reached another halt in the lowering of the lake was made and beach lines marking the edge of the water were formed. To this body of water

[30]Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, pp. 377-8, 1899.

the name *Cryder Lake* is given, from Cryder school, which is located on the beach line, where it is well developed and preserved. A possible cause for this halt in the lowering of the lake is the presence of a resistant sandstone in the valley walls near Marseilles up to at least the 540-foot level. The fact that this standstone, the Waupecan, is overlain by soft shales leads to the inference that this was a factor of considerable importance in the rate of downcutting.

Cryder Lake existed for some time in the Morris Basin, as attested by the good beach still in evidence. A beach line at this level may be traced almost entirely around the depression (Pl. III*A*). It has its best development north of Morris, where it is in part utilized as the site of Ridge Road,

Fig. 39. Gravel deposit in sec. 21, Wauponsee Twp. The larger rocks probably have been transported by floating ice which lodged on the beach. The diameter of the largest boulder shown is about 18 inches

leading northeast. It can be followed along Sand Ridge, and thence southeast to the steep bluff at the head of Illinois River, where later erosion has eliminated all trace of it. East of this point it can be observed in several places on the lowland north of Wilmington, and traced westward, on the south side, it apparently is coincident with the heavy dune sand of Sand Ridge, three miles north of Coal City. West of Mazon River it is again distinct as far as Waupecan Creek, where the narrowed valley precludes the possibility of its having been retained, if ever formed.

That portion of the beach lying in section 20 of Wauponsee Township (T. 33 N., R. 7 E.) presents certain anomalous features which appear to demand peculiar controlling conditions in that area. Here the beach ridge is surmounted by, if it does not contain throughout, large boulders of igneous and metamorphic rocks. The absence of limestone which characterizes the adjacent till suggests a more distant source for this coarse material. The prominence of the boulders gradually disappears along the beach to

the east (fig. 39), thus pointing to a localization of the controlling factors. Transportation of the boulders by floating ice which was stranded on this part of the beach seems to be the logical explanation for their concentration here. Similar boulder deposits south of the beach may have been made when the water level was higher.

Most of the area bounded by the beach shows some evidence of having been covered by a body of standing water. The elongate ridge about two miles west of Morris, however, shows no trace of having been inundated at that time. Its crest is a few feet above 540, and hence may have been slightly above the highest level of Cryder Lake. The presence of gravel and sand on the western end of this ridge at the same level as the beach lines north and south of the Illinois makes such an assumption valid.

It is clear that drainage conditions obtaining during this stage were different from those of the preceding stage. The body of water outlined by the beach remnants was little more than half as large as Lake Morris.

The absence of any extensive deposits comparable to those made in Lake Morris suggests that the water of Cryder Lake was able to transport most of the sand and silt brought to it. The character of the marginal slope and of the bottom of the basin is in harmony with this conception and leads to the inference that Cryder Lake was little more than a widened river whose high level is represented by the 540-foot contour line.

It is not improbable that there was deposition of limited amounts of sand over most of the basin of Cryder Lake during the early part of this stage, the finer sediment being carried downstream. Maximum deposits would have been made at the mouths of streams entering this lake, especially at the mouth of the Chicago outlet in the DesPlaines Valley east of the Morris quadrangle. There are terrace deposits along Waupecan Creek and Mazon River, as well as the smaller tributaries which probably were contemporaneous with Cryder Lake.

The further lowering of the outlet of Cryder Lake ultimately resulted in draining it. While this was taking place no further beach would have been formed, and the 540-foot beach would have been incised by tributary streams. Topographically, the result was a transformation of the old lake bottom into an erosion surface about 15 feet below the beach with a relatively abrupt slope up to it. Channel scars mark the position of the later channels in the wide river bottom. The lack of uniformity in the altitude of this wide flat is obviously related to the unevenness of the bed rock surface, which is exposed in places.

As indicating substages in this development, are to be noted the remnants of terraces below the 540-foot level along such streams as Nettle and Waupecan creeks. Further downcutting of this part of the Illinois Valley was restricted to a relatively narrow strip approximately bisecting the Cryder

Lake basin. Evidence as to the work done by this early river is concealed, if not entirely eliminated through the deposition by the stream of the next stage.

LATER HISTORY OF THE ILLINOIS VALLEY

At some period after the draining of Cryder Lake the present Illinois Valley was filled to overflowing by a much more powerful stream than that immediately succeeding the Cryder Lake stage. The further lowering of the outlet, however, may have caused its restriction to the narrow channel which it maintained. This stream not only transported great volumes of sand and coarse gravels from the DesPlaines gravel beds above Channahon but also was apparently able to scour the previously existing channel. It seems to have maintained a wide but shallow channel in its course over the exposed rocks above and just below the head of Illinois River. It is not impossible that these knolls of limestone and sandstone remained as islands in the streams most of the time, while the circuitous channels outlined by the gravel deposits of this stage were incised. (See Plate II.) Downstream, however, the relative weakness of the Carbondale formation permitted deeper and more concentrated erosion. The bed rock conditions east of Morris are such as might readily have caused the development of prominent rapids in the postulated stream as it passed from the resistant Pottsville to the weaker Carbondale strata. It appears probable that at the stage of maximum volume, waters were ponded in the shallow depressions adjoining the main channel of this date, and that under these conditions were deposited the sand, marl and peat beds in the area just north of Morris revealed in Bell's stripping pit in sec. 34, T. 34 N., R. 7 E. The great volume of the stream is attested by the depth of the erosion as well as by the amount and character of the deposits, but more clearly still by the low gradient which it appears to have maintained. By the time this powerful stream was somewhat reduced the pre-existing surface had been incised to a maximum depth of perhaps 35 feet. With further reduction of volume, not only this channel but the adjacent less eroded lowlands were concealed by deposits of sand and gravel. It was at this time that the prominent gravel and sand deposits at the 520-foot level bordering the flood plain of the present Illinois were laid down. The undulatory character of the surface and the "pockety" nature of the gravel and sand beds reveal their origin in sand and gravel bars in the bed of this ancient river. With the further reduction of its volume, maximum deposition by this stream was made farther and farther upstream above the head of Illinois River.

The next step in the development of the topography of the Morris Basin was the restriction of the active stream to the relatively narrow channel which it occupies now. Coincident with this was an increase in erosive

power which resulted in the development of a shallow trench within the sand and gravel flat. A temporary increase in volume is the most probable cause of this incision. This was followed by a reduction in volume and consequent deposition within the trench and at this time the present stage in the history of the Illinois opened. With the later development of the tributaries in the headwater areas, the amount of water coming down the Kankakee and the DesPlaines has been increased gradually. Corresponding to this change there has been more and more transportation of material. Only the fine sand and silt from the drainage area is being brought down, however, and the development of the rich flood plain lands bordering the Illinois in the Morris quadrangle has resulted. That this alluvial filling is only a thin coating over the gravels of the preceding stage is evident from all pits and borings made over the flood plain.

CHAPTER VI—ECONOMIC GEOLOGY

The foregoing discussion of the various geologic features of the Morris quadrangle serves as the basis for a description of the economic resources of the region. Without such basis the discussion of mineral wealth can be little more than a catalog of known resources without reference to their vertical and areal extent and without guidance for further exploration. With their relations revealed by a study of the stratigraphy, however, the restriction of coal, limestone, sand and gravel to certain areas is clear, and the size and shape of known bodies of useful materials as well as the probable character of similar material yet undiscovered may be fairly estimated.

Coal, shale and clay, stone, sand and gravel, as well as water and soils, comprise the known resources, which will be discussed in the order given. Brief reference will be made also to the possibility of finding oil in the area, although oil is not known at the present time to exist here in commercial quantity.

Coal

GENERAL RELATIONS

The Morris quadrangle lies at the northeast edge of the Eastern Interior Coal Basin, the great coal field which includes most of Illinois and parts of states adjoining on the east, south and west. Disregarding the commercially unimportant outliers of this portion of the field, the border of the basin crosses the quadrangle in an irregular line trending northwest-southeast a few miles northeast of the town of Morris. The entire quadrangle southwest of this line is probably underlain by one or more beds of workable coal.

That portion of the quadrangle underlain by No. 2 coal in commercial thickness is included in what is known as the Longwall District, a subdivision of the coal fields of Illinois and given that designation from the prevailing method of mining. This district includes part or all of Bureau, Putnam, Marshall, La Salle, Livingston, Grundy, Will and Kankakee counties.

The only coal of the area commercially important at the present time is No. 2 bed, which outcrops just northeast of Morris and underlies the southwestern part of the quadrangle. This coal marks the base of the Carbondale formation and hence has stratigraphic as well as economic importance. Thin coals are known, both from outcrop and exploration, above and below No. 2, but none so far discovered warrants development.

POTTSVILLE COALS

The coals of the Pottsville series have not been widely explored, but such openings on them as have been made indicate that there are carbonaceous beds at several horizons. These show varied development, in places being merely a thin streak of carbonaceous material while elsewhere several feet of coal may appear (fig. 24).

As noted in the discussion of the stratigraphy of the region, the coal uncovered in stripping for the clay pit at the west end of Goose Lake is considered to be a bed lying below No. 2 coal. The details of this section were included in the earlier discussion (p. 46). This, or a similar bed, was opened as a country bank a few rods southeast of the pit many years ago and essentially the same section was reported. It is probable that the full thickness of the coal bed is somewhat greater than the section shows, although no openings to the south, down the dip, have been made. Further development may reveal not only a greater thickness of coal, but the presence of roof shales as well. Plant fossils in these shales may render the exact correlation of this coal possible.

The bed of coal worked in the two shafts in section 19 of Aux Sable Township (T. 34 N., R. 8 E.) apparently has the same stratigraphic position as the Goose Lake coal. It was 28 inches thick, with variable roof and had only a limited extent. Bradley did not consider the evidence sufficiently clear to permit correlation.[31] No other openings are known to have been made on Pottsville coals, nor were these of more than local importance. Such beds have been reported in some borings, as in the case of the well at Braidwood[32] just east of the Morris quadrangle, where three coals were encountered in the 60 feet of Pottsville sediments. There is no indication that the coals below No. 2 have any better development south of the edge of the Pennsylvanian basin than where they have been encountered.

Carbondale Coals

NO. 2 COAL

This bed is widespread, of remarkably uniform thickness and character and has been mined in scores of openings. The presence of this coal in workable thickness, is the basis for delimiting the Longwall District in this State. It underlies all of the quadrangle south of its outcrop except possibly the valley of the Illinois above Morris. While the heavy drift cover prevents exact delineation of the outcrop, its approximate location is shown on Plate III, thus indicating the contact of Pottsville and Carbondale formations.

[31]Bradley, Frank H., Geol. of Ill., Vol. IV, p. 198, 1870.
[32]Log furnished by Mr. William Campbell of Coal City.

As thus mapped about 115 square miles are underlain by the Carbondale formation. In the estimate of available tonnage from No. 2 coal in this region there must be considered (1) the variation in thickness of the bed, (2) the area which is unworkable by shaft mining because of poor roof and (3) the area already mined out. The lack of reliable data on these points renders more than a rough approximation of the tonnage impracticable.

While there are few borings penetrating No. 2 coal in that part of the quadrangle lying west of Mazon River, the uniformity in thickness of the bed in the vicinity of Coal City and in the region south of Seneca leads to the inference that No. 2 is present in average thickness in the intervening area. That part of the bed which is overlain by a poor roof is probably restricted to a strip parallel to the outcrop, and approximately two miles wide. This would eliminate between thirty and forty square miles from the field available for shaft mining. It is probable that a considerable portion of this tonnage is recoverable, however, by stripping operations, which thus compensate, or partly compensate, for the assumed loss.

Figures for the total production of this area are in error by an unknown percentage and in any case serve only as a guide in this estimate, since for every ton of coal reported as mined it is probable that approximately a half a ton has been rendered unfit for mining. Estimate of this factor by calculation of the area involved in operations of the known mines gives a figure of about twenty square miles. From the original estimate of 115 square miles there is thus to be deducted about fifty square miles. Assuming an average thickness of 30 inches, the remaining sixty-five square miles contain about 183,000,000 tons.

Physical character.—No. 2 bed is characterized by the alternation of dull and bright bands of clean coal without persistent bands of impurities. Thin plates of calcite commonly are seen on vertical faces. Pyritic lenses, "bone" or shale bands and charcoal or mining dirt separate the clean coal bands, but these impurities are small in amount and so irregularly disposed that the bed as a whole shows no benches. The pyritic impurities, such as "sulphur balls," are not readily separated from the coal and hence some coal is lost in separating the pyrite. In the deeper openings the coal is relatively hard and brittle, the top coal being harder than the bottom and in most places of brighter luster. "Cleat" is nowhere well developed. In the shallower workings the coal is relatively soft and shows less difference in hardness and texture between top and bottom.

Chemical composition.—The chemical character of No. 2 coal is fairly well established for the Morris region, although but few samples from the openings within the quadrangle have been analyzed. The average for Grundy County shows a high moisture content with medium sulphur and

low ash. Determinations of heating value show an average of almost 11,000 B. t. u. on the "as received" basis.

In the appended list are presented all the available analyses of No. 2 coal from the Morris quadrangle. These were made for the State Geological Survey under the direction of Professor S. W. Parr.

TABLE 6—*Proximate analyses of No. 2 coal from Morris Quadrangle*

Laboratory No.	Form[a] of Analysis	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Carbon as CO_2	British thermal units
2624	A	17.56	35.63	36.19	10.62	1.70	.....	10200
	B	.....	43.22	43.90	12.88	2.06	.....	12373
5367	A	19.97	38.16	37.45	4.42	1.82	.65	10936
	B	.....	47.68	46.79	5.53	2.27	.79	13664
5368	A	18.95	37.60	38.23	5.22	2.46	.64	10787
	B	.....	46.39	47.16	6.45	3.04	.79	13309
5369	A	19.66	37.01	38.16	5.17	2.03	.83	10734
	B	.....	46.06	47.50	6.44	2.53	1.03	13360
2609	A	13.24	36.44	39.04	11.28	5.42	.....	10764
	B	.....	42.00	44.99	13.01	6.24	.....	12406
731	A	14.16	.....	.....	5.00	1.57	.....	11531
	B	.....	.....	.....	5.82	1.83	.....	13436
4391	A	16.43	36.64	41.25	5.68	2.36	.....	11089
	B	.....	43.84	49.37	6.79	2.83	.....	13269
4392	A	14.50	38.62	41.12	5.76	2.27	.40	11196
	B	.....	45.17	48.10	6.73	2.66	.47	13095
5373	A	17.29	38.61	36.69	7.41	2.87	1.44	10708
	B	.....	46.68	44.36	8.96	3.47	1.74	12947
5374	A	13.73	39.87	42.19	4.21	2.04	1.47	11787
	B	.....	46.22	48.90	4.88	2.37	1.71	13662
5377	A	17.01	39.48	36.74	6.77	3.32	1.05	10834
	B	.....	47.57	44.27	8.16	4.00	1.27	13055

[a]A—"As received"; B—"Moisture free."

The bed varies in thickness from 20 to 72 inches, but shows much greater uniformity than those figures indicate, a variation of less than 5 inches throughout a mine being common. Overlying the coal is gray shale, commonly 40 feet thick, in places so sandy as to be better described as a

shaly sandstone. In the No. 3 mine of the Big Four Wilmington Coal Company a relatively pure sandstone overlies the coal in parts of the mine, the more usual shale or "soapstone" coming in as a feather edge between the sandstone and coal, and reaching considerable thickness in places. The floor is characteristically gray clay, plastic when wet and possessing some refractory properties. It is an ideal stratum in which to undercut the coal and is so utilized in most workings. It is invariably called "fire clay," although its lithologic variation undoubtedly indicates equal variation in fire-resisting properties. This clay is rather uniform in thickness in a given mine, but varies from a few inches to more than 5 feet over the district. Below it is a somewhat gritty shale similar to the soapstone above the coal. In the mine of the Braidwood Wilmington Manufacturing Company the 5 or 6 inches of floor clay is underlain in places by 2 to 3 inches of coal with about 4 feet of clay below. Elsewhere the usual succession obtains.

The following descriptions of the bed have been compiled from notes by various members of the Survey:

BIG FOUR WILMINGTON COAL COMPANY, NO. 3, DEWEY SLOPE (A, fig. 40)

Main northwest 1500 feet from shaft. Roof sandstone or shale. The coal is 36 inches thick, contains sulphur balls and is very wet, especially when first opened up. Floor is fire clay.

BRAIDWOOD WILMINGTON MANUFACTURING COMPANY. SHAFT MINE. (B, fig. 40)

Main north 300 feet from shaft. Roof is a hard soapstone and makes a good longwall cover. The coal is 36½ inches thick and is rather wet. The floor is fire clay with 2 to 3 inches of coal about 5 inches below the top. Where the upper clay band is thick enough it is mined and the coal wedged down. The floor is reported to heave a good deal.

CLAYTON BROTHERS. MORRIS. LOCAL SHAFT. (C, fig. 40)

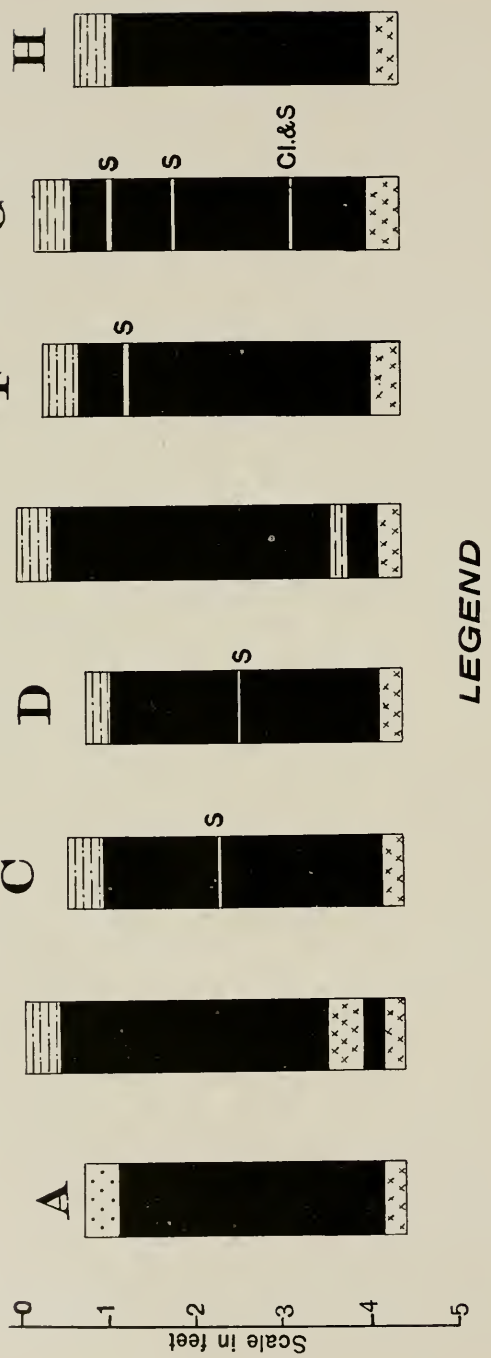
Face of northeast entry. Roof is soapstone. The coal is 38 inches thick with a local band of sulphur and coal ½ inch thick 15 inches from the top. The coal is hackly in fracture and brittle in texture. Floor is fire clay.

WILMINGTON STAR MINING COMPANY. No. 6 (D, E, F, G, fig. 40)

Face southwest entry. Roof gray shale with a black clay at base in places. The coal is 41 inches thick with a total of 3 inches of sulphur and clay in three bands. The 5-inch band of coal is bright while the lower part is duller. The coal shows a hackly appearance on the whole, is solid, brittle, and has no continuous impurities. Floor is fire clay.

WILMINGTON STAR COAL COMPANY, MINE NO. 7, COAL CITY (H, fig. 40)

Face northwest, south entry—roof soapstone. Coal hard and brittle, the top coal harder than the bottom and in most places brighter. Cleat poorly and irregularly developed. The coal shoots into good-sized blocks. There is very little calcite present; near the middle of the bed in parts of the mine there is a band of mother coal and sulphur. The floor is fire clay averaging about 7 feet in thickness. Undercutting is done in the clay to a depth of 18 to 24 inches. Shale is reported to underlie the clay.



A. No. 3 Dewey Slope, Big Four Wilmington Coal Co.

B. Braidwood Wilmington Manufacturing Co.

C. Clayton Bros.

D, E, F, G. No. 6, Big Four Wilmington Coal Co.

H. No. 7, Big Four Wilmington Coal Co.

Fig. 40. Graphic sections of No. 2 seam, Morris Quadrangle

BELL SHAFT. MORRIS. LOCAL

Roof is soapstone with 1 to 5 inches of clod at the base. The contact with the coal is somewhat uneven. The bed is 42 to 48 inches thick and contains sulphur lenses and some shaly bands. The coal is soft, of dull luster, brittle and showing roughly cubic fracture. The floor is a gray fire clay, with plant impressions, but a dark gray "slate" is met locally where it cuts out part of the coal.

HEATHER SHAFT. MORRIS. LOCAL.

Roof is soapstone with 6 to 30 inches of gray shale or "clod" just above the coal. The contact with the coal bed is even. The coal is 30 to 36 inches thick without partings. Soft "brown sulphur" lenses occur about 6 inches from the top of the seam. Floor is a gray clay, which makes undercutting easy.

MITCHELL SHAFT. MORRIS. LOCAL.

Roof is soapstone 27 feet thick. Contact with coal even. The bed is 24 to 34 inches thick, average 30 inches. The coal is brittle and mainly of dull luster. "Sulphur balls" are irregularly distributed but are not abundant. Floor is a fire clay.

While on the whole the continuity of No. 2 coal is noteworthy, there are some marked deviations that are of interest from the scientific as well as the economic aspect. The prominent "roll" encountered in No. 7 mine of the Wilmington Star Mining Company west of Coal City has already been noted. This was described and figured in an earlier report[33] on this region and need not be re-described here. Less prominent "rolls" are met in most mining operations. Some of these appear to be original irregularities in the surface of the swamp in which vegetable matter accumulated. Others are clearly due to intraformational erosion which has in places removed the overlying soapstone and even the upper part of the coal bed, the gap being later filled commonly by crossbedded sandstone. These irregularities always interfere, often seriously, with mining operations. Dislocations of the beds, known to the geologist as faults, are not rare, but are of such dimensions that they have no commercial significance.

COAL BEDS ABOVE No. 2

Throughout the southern part of the Morris quadrangle one or more coal beds are found over No. 2 coal. The absence of such upper beds farther north is, of course, due to the absence of that part of the stratigraphic column. It is not clear whether this lack of the higher strata is because of non-deposition or because of erosion. The apparently lenticular form of the coal beds, however, leads to the inference that the northern limit of the depositional swamps was south of Coal City.

With the exception of one of these coal beds, it is impossible to make a satisfactory correlation of them even from well to well. The reported

[33]Cady, G. H., Coal Resources of District I (Longwall): Ill. Coal Mining Investigations Bull. 10, p. 73 1915.

presence of a thin coal about 75 feet above No. 2 over the area between Waupecan Creek and Coal City leads to the inference that one of these beds may fairly be correlated, although absolute continuity is improbable. The one bed which appears to be persistent outcrops in section 20 of Wauponsee Township (T. 33 N., R. 7 E.) on Waupecan Creek. Here it was worked at an early date, as reported by Bradley,[34] who classed it as No. 4 coal. This bed shows a maximum development of 18 inches, but in most places pinches out to a mere streak in short distances. This same bed was worked on Mazon River in the vicinity of Sulphur Springs and in section 13 of Goose Lake Township (T. 33 N., R. 7 E).

COAL MINING

Early mining in this region was on a small scale. While some coal was taken from the outcropping beds in Goose Lake, Mazon River and Wau-

Fig. 41. Refuse dump 60 feet high, containing shale and impure coal from mine near Coal City

pecan Creek, the amount was insignificant in comparison with that removed from No. 2 bed, the operations upon which will be noted in somewhat greater detail.

Strip mines were operated to a limited extent, but most of the coal cut was hoisted through shafts. The first of these were placed about a mile back of the outcrop of the coal beneath the drift. Extensive workings were not attempted, a new shaft being sunk as soon as the development from one bottom had proceeded a few hundred feet. This procedure was necessitated by the mining methods in use which met drainage, haulage and ventilation problems by withdrawing from the field of operations. When the most

[34] Bradley, Frank H., Geol. Survey of Ill. Vol. IV, p. 194. 1870.

favorable sites for this type of mining had been found and utilized, openings were made to the northeast where roof conditions made operations uncertain and to the southwest where the greater depth to the coal increased operating expenses. But few shipping mines were attempted and the total production was not great from the early mining operations.

With the discovery of thicker coal in the Braidwood district large shipping mines were started. These were profitable and the employment of the longwall system gave a high percentage of extraction. The huge dumps of shale and dirty coal which accumulated in these operations dominate the landscape in the vicinity of Coal City and indeed constitute the most prominent relief feature of the topography (fig. 41). Such dumps appear as far as 2 miles north of Coal City and may be seen south and east beyond the limit of the quadrangle. In 1920, but one shipping mine in the area was

Fig. 42. Surface equipment for local mine. Mitchell shaft, Morris

being worked. This was the No. 7 mine of the Chicago, Wilmington and Franklin Coal Company, and was located in section 5, 2 miles west of Coal City. No shaft has been sunk west of this point and because of the expense involved it is unlikely that the coal to the west will be worked in the near future. To supply part of the coal demand several wagon mines are operated intermittently. Three shaft mines known as the Mitchell, Heather, and Bell mines respectively are located north and west of the town of Morris. Figure 42 illustrates the surface equipment at the Mitchell shaft which is typical of these operations. Northeast of Morris two small strip mines have been opened. One, the Bell stripping, is in the SE. ¼ sec. 34, and the other, the Davidson stripping, is about one mile farther east. Figure 43 shows the thickness and character of the till overburden. The coal was partly under water when this place was visited.

Clay and Shale

As is usual in a coal mining region there are in the Morris area certain argillaceous deposits which are adapted to the manufacture of various clay products. The available material, however, is not restricted to the "Coal Measures" but is found in beds of earlier as well as later origin.

ORDOVICIAN SHALE

The Upper Ordovician section includes a shale member, the Maquoketa, which is quite uniformly about 60 feet thick and which outcrops beneath the drift in the belt mapped on Plate III. No surface exposures of this formation occur, however, and the drift and bed rock cover may be too thick for

Fig. 43. View of small strip pit northeast of Morris. Note boulders in till of the overburden

any but large scale operations. No tests have been made to ascertain the quality of this shale, which appears from drill cuttings to be free from grit or other impurities. Tests made on samples from the weathered portion of this formation in southwestern Wisconsin show it to be but slightly calcareous. It was there recommended for hollow ware and probably is suitable for paving brick though not in any sense a refractory material. It is likely that similar results would be obtained from tests of the Maquoketa of Grundy County.

PENNSYLVANIAN SHALE

From the Pottsville formation of the Pennsylvanian strata certain shales have been found adaptable to several uses. Such beds lie beneath the coal at Jugtown in sec. 16, T. 33 N., R. 8 E., and are now being worked by the Haeger Brick and Tile Company at the west end of Goose Lake. Strati-

graphically these lie high in the Pottsville and perhaps are to be correlated with the clays mined at Rock Island, Colchester, and other places in the western part of the State. While the Jugtown clays are not known to be refractory, some of those of the Goose Lake depression are. In fact, tests made show that some of the shales compare very favorably with the best fire clays of the State. For that reason the Goose Lake clays are worthy of more than passing notice.

Even a cursory examination of this old lake basin shows that the stratigraphic relations are not simple. Three outstanding factors combine to produce the irregularities observed. There is first the basin's relief, which though low is still effective in producing an intricate areal pattern in the slightly dipping beds of the area. As a second factor there is the warping of the beds themselves which gives great variety to the general southward dip of the formation. Thus there are at the clay pit, at the west end of the former lake, beds dipping about 10 degrees south. Farther west these beds dip southeast about 1 degree and to the north they are dipping almost imperceptibly northward. In many parts of the basin the structure is not revealed by the outcrops and indeed the extent to which the recorded dip measures original inclination rather than warping is not known. The effect of the attitude of the beds, however, is to increase the complexity of their areal pattern. A third important factor is the lenticular character of the beds themselves. This is shown by the variation in the section from place to place as revealed by excavations and drilling.[35] Thus the sandstone encountered in the Haeger clay pit is distinctly lenticular. The coal, which is there about 60 inches thick, appears to be about 24 inches thick a few rods distant. Other stringers of coal from 1 inch to 6 inches thick can not be correlated from one test hole to another. In the same way the shales of the section appear to be lenticular. As yet sufficient work on either the extent of the shale beds or their refractory properties has not been done to delimit accurately the area underlain by fire clay. It is clear, however, that near the center of the lake basin some of the outcropping shales are distinctly refractory. One sample sent in to the Ceramics Department of the University of Illinois gave high tests,[36] fusing with cone 31 at a temperature of 1750°C. or 3182°F. This is a No. 1 fire clay and on the basis of its behavior when mixed with water would be classed as a semi-flint clay. As noted above, however, field data at hand do not make clear the extent of the area underlain by the more valuable deposits of refractory shale.

In the rocks stratigraphically over the Pottsville deposits just mentioned there occur similar shale and sandy shale beds which should be listed in a catalog of the clay and shale resources of the area.

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[35]The writer gratefully acknowledges his obligation to Mr. E. H. Van Schoick of Chicago Retort and Fire Brick Company, Ottawa, for data on the drilling tests made in the Goose Lake basin.

[36] Parmelee, C. W., Personal communication.

The "soapstone" roof of No. 2 coal is in most parts of the quadrangle a slightly gritty shale. In places it is very sandy but more frequently it is a clean shale. This is adapted to the manufacture of brick and drain tile although not mined with the coal for that purpose. A vast accumulation of this material, more or less mixed with coaly matter and pyrite, is found in the prominent mine dumps of the Coal City area. That this is available for the making of drain tile has been demonstrated by the commercial tests made by the Haeger Brick and Tile Company of Coal City.

It is not known exactly what deposits were used at Jugtown. Without doubt they belonged to the Pennsylvanian which comes practically to the surface in that vicinity. Whether the shales used were lying above or below the coal is not known but these may have been just below what is considered No. 2 coal. No tests on the refractory properties of this shale have been reported, hence it is not likely a high grade fire clay.

There are in the upper part of the Carbondale formation other shales which undoubtedly have properties rendering them suitable for brick and tile manufacture at least, but no attempt to test them out has been reported. Such beds are found below the Waupecan sandstone and farther down in the formation as exposed on Mazon River in the vicinity of Claypool Ditch.

PLEISTOCENE CLAY

Still younger in age and of different origin are the deposits referable to the Pleistocene or Glacial epoch. Two of these are being worked and the presence of other deposits of similar character is to be expected. The older of the two comprises the finely laminated lake clays on the East Fork of Nettle Creek in Morris and which are worked at the Morris Tile Factory. The deposit now worked is of rather limited areal extent, being restricted to an erosional depression in the surrounding Pennsylvanian sandstone. This deposit is a remnant of a rather extensive series of beds laid down in a glacial lake of pre-Marseilles age. Most of the original material has since then been removed by glacial and stream erosion. In protected places, however, remnants may be found.

These clays have long been used for brick and drain tile which, if properly made, appear to be entirely satisfactory. For further discussion of these beds the reader is referred to the chapter on Descriptive Geology (pp. 58-59).

The other Quaternary deposit is glacial clay, or till, a deposit made by the ice directly without the intervention of water to an appreciable extent. This material, while present over all of the quadrangle, is in most places so filled with cobbles and boulders as to be unavailable as clay. Locally it is essentially free from boulders and, as at Coal City, becomes a source of raw material for brick and tile. Much of the ground moraine area south

of Illinois River above the 560-foot level may include workable beds similar to that at Coal City.

In early times brick and drain tile were made from all the types of deposits noted. In addition a rough type of pottery was manufactured at Jugtown from the Pennsylvanian shales. No other such operation has been reported from this area.

At present no pottery is being made and but two plants for brick and tile are in operation. The outlook for the future, however, includes the preparation of ground fire clay from the Goose Lake beds and operations looking to the establishment of this industry are already under way.

Stone

Both sandstone and limestone are available for structural work. The former has been used to only a very limited extent, and the latter very considerably.

The sandstone is of Pottsville age and that which was quarried outcrops just east of the Morris quadrangle between DesPlaines and Kankakee rivers. Ponds of regular shape mark the sites of the early excavations, and piles of dimension blocks reveal the character of the product, a soft stone of light color and of medium coarse grain. It was readily worked but probably the amount of water encountered was a serious obstacle to quarrying. No other sandstone quarry in the quadrangle is recorded.

The Galena dolomite of Middle Ordovician age was similarly used for construction at an early date. A few churches and schools in the region were built entirely of this stone and more commonly it served for barns and foundations. For such purposes the old Lisbon quarry, as well as one in section 34 of the same township and another in section 24 of Saratoga township (T. 34 N., R. 7 E.) Grundy County, were originally opened.

While undoubtedly available for such use, the buff weathering of the stone renders it unattractive and there has been little reason for continuing the expensive operation of quarrying and cutting. As a result the quarrying now is carried on solely for the preparation of road material and an increasing mileage of crushed stone roads is being laid out. Lisbon Township owns the quarry site in section 21 and this is in operation from time to time as road material is needed.

The importations of crushed dolomite from the large quarries at Joliet have made impracticable the opening of other quarries in the quadrangle. The use of the Galena dolomite as a fertilizer to correct soil acidity has not been attempted. Laboratory tests [37] indicate a high neutralizing power for

[37]Tests made by Mr. Victor E. Spencer of the Agronomy Department, University of Illinois, on samples of both Galena and Maquoketa limestones submitted by the writer.

this rock and large scale experiments are suggested. Another limestone, the Maquoketa, which outcrops in the eastern part of the quadrangle is also of such purity as to be excellent for application to acid soils. Because of the interbedding of argillaceous strata with the limestone in Aux Sable Valley and the topographic position of the beds along the Illinois, large-scale operations are probably impracticable. As a local supply, however, such beds should be considered, since laboratory tests show this rock to have high neutralizing power.

A third source of fertilizer of this same type is found in the Quaternary deposits near Morris. In the overburden removed from the coal at Bell's stripping in the swamp area in section 34 of Saratoga Township (T. 34 N., R. 8 E.), there is a stratum of shell marl of such purity, thickness, and position as to be readily available for use as fertilizer. Its unconsolidated state renders it unnecessary to crush or otherwise prepare it for use, so that a limited supply is immediately available. The origin of this deposit leads to the inference that it is not widespread and since it has an average thickness of less than one foot it is believed that this will never be other than a supply to meet local needs.

Sand and Gravel

All deposits of these materials are of Pleistocene age. They comprise outwash deposits from the receding ice sheets and terrace deposits of fluvial origin. While restricted to certain belts, these deposits are sufficiently abundant to supply all the needs of the area for an indefinite period.

The main deposits lie within the old valley walls of the Illinois and are found up to an elevation of about 525 feet. Local gravel pits line the valley on both sides of the river and are found in some of the tributary depressions as well. The sites of many of these pits are shown on Plate II.

In composition the gravels are similar to those of the DesPlaines Valley, but are finer with a greater proportion of sand. Because of the proximity of the extensive DesPlaines gravels, the utilization of their downstream equivalents has been strictly local. They are available for both gravel and concrete road construction but because of the lenticular character of the deposits are expensive to work.

Aside from the beds within the main valley there are smaller related deposits along the major tributaries. Typical of these are the pits in sections 7 and 18 of Aux Sable Township (T. 34 N., R. 8 E.) along Walley Run and Aux Sable Creek.

Still another type is that found in the recessional moraines in the northwest part of the quadrangle. These comprise ill-assorted material including gravel, sand, and clay in varied proportions. The deposit opened in section 31 of Lisbon Township (T. 35 N. R. 7 E.) is one of this type. The material

is available for road building but is not clean enough for other uses to which sand and gravel are commonly put.

Water

The water resources of this area, while not in themselves of commercial importance are indirectly of the greatest importance in the industrial development of the region.

The Morris quadrangle, like the area surrounding it, is abundantly supplied with water. While in practically all cases it is "hard" water and in many it is a "sulphur" water as well, still the needs of the inhabitants are adequately supplied. In the vicinity of Sulphur Springs there are three wells from which a relatively "soft" water issues. The logs are not available and the horizon of the supply is not known. It is presumably some Pennsylvanian sandstone. Intermittent springs are common but are little used except for stock. Permanent springs, on the contrary, are not common. One of the largest in the vicinity lies a short distance west of the quadrangle in Nettle Creek Township. This is a remarkably cold water from which bubbles of marsh gas continually emerge.

Shallow wells, by which are meant those which do not penetrate the bed rock, are very common. In the valley of Illinois River below the 540-foot level such wells commonly reach an abundant supply at depths of less than 20 feet. Such a well is that in the northeast quarter of section 33 of Saratoga Township (T. 34 N., R. 7 E.) less than a mile north of Morris. One of the deeper surface wells is that recently drilled at the Stein School 1½ miles southeast of Morris where a good supply of water was found at 64 feet, probably but a few feet above the Pennsylvanian sandstone. Outside of the main valley the depth of the wells varies from place to place, the deepest surface wells being in the northeast part of the quadrangle where the drift is thick. Here reported depths of 100 feet are not rare.

While these wells in surficial material are found throughout the quadrangle, the search for water below the bed rock has been prosecuted systematically for two reasons. First, because it is believed that the chance of contamination is less, and second, because the deeper wells are usually artesian and the supply is more constant. While the artesian pressure is frequently not sufficient to produce a surface flow, or if produced at first not long maintained, the pumping required is much less than that for water from shallower wells. These deeper wells are drilled to depths which vary notably for several reasons.

Differences in topography make obvious differences in the depth at which water will be found. A second factor is the position within the quadrangle. Plate I shows clearly that a given water-bearing stratum, as the St. Peter

sandstone, lies at greater depth toward the southeast part of the quadrangle. A third factor is the variation in the formations themselves. Thus a boring may meet a fair supply of water at 100 feet within the Galena formation while a well nearby may have to be sunk 200 feet in the same formation before finding any water. Similarly in the Pennsylvanian series a porous water yielding sand in one place may correspond stratigraphically to an impervious shale nearby.

As a rule the water from the deep wells is hard and those penetrating the "Coal Measures" are more or less sulphurous. They are in most cases very regular in supply although over a long period of years the gradual lessening in the flow is perceptible. In some cases this is due to the failure of the supply, in others to the slow clogging of pipes with iron rust, clay, etc. Some wells have ceased abruptly and disturbance by blasting or earthquake has been assigned as a cause. The permanence of the flow and the height of the water column, as well as the character of the water, are closely related to the source of supply.

Drilled wells draw water from several formations. In the southern half of the quadrangle many wells are bottomed in the Pennsylvanian beds. Because of the proximity of the outcrop and the consequently restricted area of intake, this source of supply is less reliable than that next below. The common practice is to drill for water in the upper beds and if it is not found there, to continue to the beds below. In places the water of the "Coal Measures" is too sulphurous and in these cases drilling is usually continued, the upper waters being cased off to prevent their joining the purer water encountered below.

The next water-bearing stratum below the Pennsylvanian rocks is the Galena dolomite. This has no definite water horizon but is rarely completely penetrated without finding a good water supply. While uniformly "hard" this is an excellent source for water. More wells obtain water from this stratum than from any other in this area.

Below lies the St. Peter sandstone, a noted aquifer and one that is frequently reached in the northwestern part of the quadrangle but rarely elsewhere.

The next water-bearing stratum is in the Lower Ordovician beds where the sandstones and limestones of the Prairie du Chien formation supply water that in most cases is abundant but rather highly mineralized. These beds have been tapped but no well is known to give water from these beds at present. One well in section 10 of Saratoga Township (T. 34 N., R. 7 E.) which is reported as 1,200 feet deep presumably is supplied from this source but the lack of an accurate log renders this uncertain. In this case the water is too highly mineralized for domestic uses and a second well stopped in the Galena dolomite furnishes the supply.

A still deeper supply is that in the "Potsdam" beds of Cambrian age. This has been reached in two wells, that at Minooka, 2,100 feet deep, and that on the farm of Abe Hoge in section 25 of Nettle Creek Township (T. 34 N., R. 6 E.). This water was in both cases found to be under considerable pressure but was so highly mineralized as to be suitable for stock only.

The conditions requisite for artesian pressure obtain in all parts of the quadrangle and with few exceptions the water in drilled wells rises many feet above the source stratum. As noted earlier, the flowing wells are not rare although pumping is frequently resorted to as a means of furnishing an adequate supply. Particularly is this true in the case of old wells.

Adequate data are not available to show the relative pressures obtained, but the water from the Cambrian beds is under the greatest head and the shallower wells show a lower pressure which roughly corresponds to the depth of the source. At least one flowing well has been reported from the drift. This was drilled in the valley fill of the Illinois to a depth of 53 feet and a flow of 20 gallons per minute obtained. The Galena was just penetrated, however, and although the supply was reported to come from the surface material the assertion cannot be proved. On Plate II no attempt has been made to distinguish between wells having artesian pressure and those which actually flow, since such distinction would necessitate annual revision. All surface wells may therefore be considered as non-artesian and all deep, or bed rock, wells as artesian.

Some data as to the height of the water level in these wells have been obtained, but this, too, is variable. In general the water level is higher at the northwest and lowest along the Illinois valley, ranging from about 600 feet above sea level in the former area to less than 500 feet in the latter. South of the river the level attained is about 550 feet; but the data here are few, most of the wells not penetrating bed rock. For details as to the supply and character of waters in this area the reader is referred to a recent report by the Survey.[38]

Soils

While the minute differentiation of soils lies outside the province of the geologist the close relation between the geologic events of a region and the formation of its soils makes a review of the soil determination of interest. On that portion of the Morris quadrangle lying within Grundy County many soil types have been mapped as a result of a survey made by the Illinois Agricultural Experiment Station.[39] The Kendall County portion has not yet been mapped.

[38]Anderson, C. B., Artesian waters of northeastern Illinois: Ill. State Geol. Survey Bull. 34, 1919.
[39]Hopkins, Cyril G., et al., Soil Survey map of Grundy County.

The soils reported are listed below:

1. Deep brown silt loam
2. Brown silt loam
3. Brown silt loam on rock
4. Brown sandy loam
5. Brown sandy loam on rock
6. Brown sandy loam on gravel
7. Brown-gray silt loam on light clay
8. Brown-gray sandy loam on light clay
9. Yellow silt loam
10. Yellow-gray silt loam
11. Yellow-gray sandy loam
12. Yellow-gray sandy loam on gravel
13. Mixed loam
14. Black sandy loam
15. Black clay loam
16. Peaty loam on clay
17. Deep peat
18. Muck
19. Dune sand

Areally the brown silt loam is the most important. This, with the associated black clay loam, covers a large part of the quadrangle. A large part of the remaining area is covered by the brown sandy loam which has developed from the original till surface through weathering and the introduction of stream and wind-borne sand. The prominent area of this type of soil is in the Coal City region.

Most of the other types of soil are restricted to the Illinois Valley where, as noted in the earlier chapters, the geologic events recorded have produced areas of deep sand and gravel, of bed rock, of silts, and of swamp deposits. These beds give rise to some of the reported soil distinctions, since not only the surficial character but the sub-soil conditions are considered. Along the stream courses are found the upland timber soils, including yellow-gray loams either silty or sandy. Where slope wash is more prominent yellow silt loam is found, the accumulation of black soils being prevented by the constant removal of the finer material. The soil of the alluvial flats of the Illinois is classed as a deep brown silt loam, and is of such thickness that the character of the sub-soil is unimportant. The flood plains of the smaller streams are so continually being added to from various sources that their soil covering is well classed as mixed loam.

The undrained areas of the Cryder Lake basin as well as of the later drainage courses provide conditions for the development of the peaty or muck soils there found. The dune sand is of limited extent and restricted to the southeastern part of the quadrangle.

It should be noted that the soil distinctions, while clear, are to a certain extent arbitrary and that in any classification the pure types have undue prominence while the more common gradational types are relatively inconspicuous.

In general, the soils of the quadrangle are transported and have resulted from the weathering of a variety of materials. They are very fertile on the whole, the poorest lands being in the area where bed rock lies near the surface.

Oil

In an examination of the area for determination of the possibilities of the presence of oil, there are three major factors to be kept in mind: (1) the presence of any oil in the region in either large or small amount, (2) the presence of beds which are known to contain oil in other localities, and (3) the presence of such structures as favor the accumulation of oil.

Very few, if any, tests for oil have been made within the limits of the quadrangle, the nearest which has been reported being a few miles east of Minooka on the north bank of DuPage River. The only discovery of oil of even small amount was within the No. 7 mine of the Wilmington Star Mining Company, where a small seepage was found several years ago.

Within the Morris quadrangle there are two formations at least which are known elsewhere to furnish oil in commercial quantity. These are the Pennsylvanian beds, which outcrop at the surface and dip to the southwest beneath a fairly heavy cover of glacial drift, and the Galena dolomite, which outcrops in the northwest portion of the quadrangle, and which is probably to be correlated with the so-called "Trenton."

As was noted in the chapter on the structural geology of the area, the Ordovician formations may lie in a southeastward pitching fold whose axis runs through Coal City. As was pointed out, however, because of the paucity of data this structure cannot be considered as determined. If it exists the broad belt there outlined would be the most favorable locus for drilling.

The contours on the surface of St. Peter sandstone, as represented on Plate III, show an irregularity in the southwest part of Saratoga Township. Two interpretations of the data were presented on p. 30. On the assumption that this irregularity results from the upwarping of the Ordovician beds, this area would be the logical place for testing with the drill.

With regard to the Pennsylvanian beds, it is evident that the accumulation of oil in commercial quantity is not likely to have occurred in that portion lying within several miles of the line of outcrop since here the beds appear to have a fairly uniform southwestward inclination. Between the apparent trough, southwest of Coal City, and a similar but less marked downward fold just west of the quadrangle lies an area where the beds appear nearly flat.

If any of the sandstones here contained oil, as has not been demonstrated, this would be an area in which an accumulation might be expected.

In the absence of any thorough drilling for this region, it should not be assumed that there is no possibility of oil production, although as indicated in the above statements, there is little to indicate the possibility of finding oil in commercial quantity.

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MORRIS QUADRANGLE
BULL NO. 17 PLATE I

Topography from map surveyed in cooperation with U. S. Geological Survey

Scale 1:62500
1 Miles
1 Kilometers
Contour interval 20 feet
Datum is mean sea level

Geology by H. E. Culver
Surveyed in 1920

SURFICIAL GEOLOGY AND ROCK OUTCROPS OF THE MORRIS QUADRANGLE

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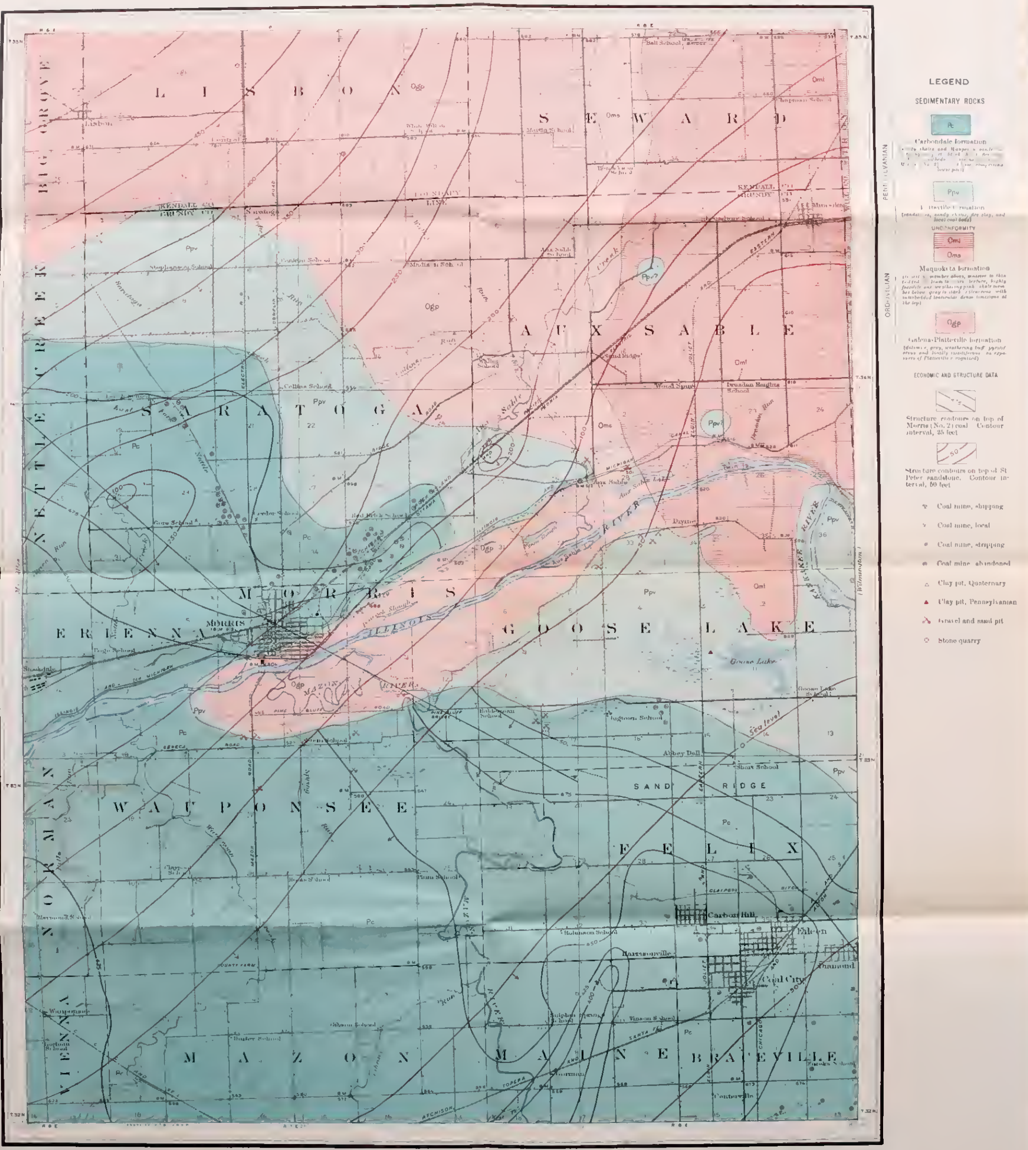
MORRIS QUADRANGLE
BULL. NO. PLATE III



Topographic base map surveyed in cooperation with U. S. Geological Survey

Geology by H. E. Culver
Surveyed in 1919

ECONOMIC, STRUCTURAL AND AREAL GEOLOGY OF THE MORRIS QUADRANGLE

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